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NEW YORK, APRIL, 1888.

THE proposed meeting of the British Iron & Steel Institute in the United States has been postponed for a year. The reason given in an official minute by the Secretary is that prominent members of the American iron trade have advised it, on the ground that public attention will be so largely absorbed by the Presidential campaign next fall, that the meeting will not receive the consideration it deserves if then held.

The visit of the Institute to this country, if present intentions are carried out, will be made in 1889. A decision as to the place and time of the meeting will be made hereafter.

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MOST of our readers have heard of the *Stourbridge Lion*, which was built in England, and was one of the first locomotives in this country, having been put upon the Delaware & Hudson Canal Company's railroad line in Pennsylvania by Mr. Horatio Allen many years ago. Some of them probably saw the boiler of this old engine, which was on exhibition at the Chicago Exposition of Railway Appliances in 1883. What was done with the boiler after the Exposition we do not know, nor does it seem easy to procure any information.

The National Museum at Washington has received from the Delaware & Hudson Canal Company a full-sized model of the *Stourbridge Lion*, which was recently constructed in the company's shops from the old drawings, and which was exhibited in the great parade during the Constitutional Centennial in Philadelphia last September. The authorities of the Museum are now anxious to secure, if possible, the original boiler, but have so far been unable to ascertain whether it is still in existence.

If any of our readers have any knowledge of its present whereabouts, they are requested to communicate with Mr. J. E. Watkins, Curator of the Department of Transportation of the United States National Museum, at the Smithsonian Institution, in Washington.

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PITTSBURGH papers report that some excitement has been caused among railroad men in that neighborhood by advertisements calling for 500 engineers, 500 firemen, and 500 brakemen to go to China under a five years' contract at high wages. A number of men are reported ready to give up their present situations and go.

As a matter of fact, the only railroad now actually under construction in China is a short line, the building of which is in the hands of English parties who are not at all likely to come to this country for men. Some other lines are projected, but the Chinese move slowly in such matters, and it may be a long time before anything is really done; when it is done materials and men are much more likely to be drawn from Europe than America. There has been talk of a concession to Americans for building railroad lines, but no actual grant has been made. Even if it had, it would be a long time yet before a demand could arise for the services of any considerable number of trainmen. Railroad men would do well to let Chinese contracts severely alone.

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ADVICES from the surveying parties employed on the Nicaragua Interoceanic Canal represent that the work so far is proceeding very favorably; no obstacles have yet been encountered, and the Government and people of the country have received the engineers favorably and granted them every facility for their work. So much has been done on the Atlantic side that Chief Engineer Peary expects to start a party from the Pacific terminus early in April.

The Construction Company has succeeded in securing a favorable charter from Congress, and will soon reorganize under that charter. As soon as this is completed, arrangements will be made for the active prosecution of work on the Canal.

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THE Army will receive a considerable addition to its artillery material should the bill prepared in committee be passed by Congress. As noted elsewhere, this bill provides for the construction of a number of large guns of approved modern design, and also for the establishment at the Watervliet Arsenal of a thoroughly equipped factory for the construction of steel guns of the largest class. With the facilities now at hand in this country for furnishing steel castings and forgings, this would enable the Ordnance Bureau to turn out guns as fast as we are likely to want them. At present, indeed, there seems to be no pressing need of any; but a modern gun cannot be made in a hurry, and it is just as well to have some ready in case of an emergency.

In this connection it may be noted that the cast-steel gun made in Pittsburgh for the Navy will be ready for trial before very long. Its performance in comparison with the built-up steel guns will be watched with much interest, and the results may do much toward settling some vexed questions.

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NOTHING has been said or done in Congress so far in relation to special appropriations for the increase of the Navy. Probably nothing will be brought forward at the present session, partly because other matters claim attention, and partly because the new ships, whose construction

is already authorized, will require all the attention of the Navy Department for some time to come. It is just as well, probably, that nothing further should be done until the new vessels now in hand pass from the experimental and constructive stage into actual use. With a free use of all our present facilities it will be two or three years before the new ships are all afloat, and it will be time enough then to take steps toward building more. Fortunately there is no present prospect that their services will be required in actual warfare, and it is to be hoped that this state of affairs will continue.

If any legislation is to be brought forward this year, it should be rather in the direction of organizing a reserve naval force both of vessels and men; but so far this has received little attention at Washington, though the discussion has been quite active elsewhere.

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THE State of Massachusetts proposes to establish a Naval Reserve on its own account. A bill now before the Legislature, which has received favorable consideration in committee, provides for the organization of naval battalions as a part of the State militia. These battalions are to have their headquarters in the seaport towns of the State, and are to consist each of 100 men, with the proper complement of officers; they are to be placed on the same footing as the organized land militia of the State in all respects except that their training will be naval and not military. They are to be composed of men familiar with seafaring pursuits and are to be drilled in naval exercises, the use of naval weapons, and if possible in the handling of large guns.

The bill proposes that instead of the annual tour of camp duty, which is a part of the militia service, the naval battalions shall have their yearly training on board ship. For this purpose it is expected that the United States Government will be willing to provide vessels at the proper season.

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THE ships now under construction for our Navy will surpass in size and fighting power anything that we have ever had; but the largest of them is small in comparison with the great warship *Italia*, of the Italian Navy, which is illustrated and described on another page. This ship is equalled in size and weight of guns by only a very few now afloat, and in her construction the builders seem almost to have reached the limit of weight and power possible for a sea-going vessel. One of our new battle-ships would stand very little chance in a direct contest with the Italian monster.

None of these big ships, however, have ever been tried in actual warfare, and their value is still uncertain. For the ordinary service of a navy in time of peace they are not of much use, being too heavy and costly to serve as cruisers, and while they may be almost impregnable against direct attack, it is not at all certain that they might not be outmanœuvered and rendered practically useless by lighter and more manageable ships. In the not improbable contingency of a war in Europe there may be an opportunity for trial of the relative merits of the different classes of vessels which have come into use since the last contest.

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IN a recent article on the Nordenfeldt submarine torpedo boat, the London *Engineering* says that the United States Government has decided in favor of these boats as a permanent arm, and is carrying its decision into practice.

Our contemporary is somewhat ahead of the times, the fact being that nothing has so far been done by our Navy Department in relation to the construction of submarine boats except to advertise for proposals for such vessels. Until these proposals are received and considered, it is entirely too soon to assume that the Nordenfeldt or any other plan will be adopted. From the experiments made abroad we have little doubt that these submarine boats are the best and most efficient heretofore constructed. It does not follow, however, that no improvement is possible or that any better plans can be devised. The Navy Department may adopt the Nordenfeldt plan, or it may adopt something entirely new, but no positive action has yet been taken.

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RECENT torpedo experiments in England have apparently shown that the charges heretofore used in torpedoes are not sufficiently large. The experiments indicated that 100 lbs. of explosive cannot be relied upon in an attack on a large vessel, and that 150 or 200 lbs. would hardly be sufficient to charge a really formidable torpedo. These experiments also seem to indicate that the locomotive torpedo as controlled from the shore or from a vessel is not by any means as reliable as its advocates claim, and that under many circumstances it would be extremely difficult, if not impossible, to send it where it is wanted.

The fact is, that the more extended the practical experience with torpedoes is the more unreliable they seem to be; and it is evident that the high opinion that has heretofore been entertained of them as weapons for offense and defense must be considerably revised.

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MARCH 12, 1888, will be a memorable day in the history of New York. On that day its citizens had an opportunity to study the condition of a large city deprived of all means of transportation. The storm which came up late on the night of March 11 was the greatest for many years, if not the greatest on record, and on the following morning every line of public conveyance was found to be disabled by the combination of high wind and drifting snow. For an entire day there was hardly any method of travel possible except walking, and that was extremely difficult. The result was a complete paralysis of business, which was more marked as the storm not only stopped movement within the city itself, but also put an almost complete stoppage on all ingress from without and all egress to other places. The city was thus for the time thrown entirely on its own resources, at the very time when they were necessarily limited.

The results of the study were disagreeable, to say the least, and in many cases serious. The mere fact that in so large a population the greater proportion were prevented from going about their usual daily callings, and that the ordinary conditions of life were entirely changed for two or three days, was sufficient to cause much loss and trouble, while cases of serious bodily injury were not few, and those of minor suffering and inconvenience almost innumerable.

Most people recognize in a vague, general sort of way how entirely a large city is dependent for its existence on its connection with the country outside, but it takes an experience like that of the great storm to bring it home to them. New Yorkers who experienced the blizzard and its

results will not soon forget it, and will, for a time at least, have a realizing sense of the power of such a storm.

The whole matter was a curious illustration of the impossibility of freeing ourselves from dependence upon nature. In the presence of certain unfavorable atmospheric conditions the latest and most approved appliances of civilization proved of very little use, and men were compelled to depend on their own physical powers as they have not done before for many years.

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ONE of the most noteworthy incidents of the storm was the utter break-down of the elevated railroad system. On the first day of the storm three of the lines of that system were completely stopped. The fourth—the Second Avenue line—which has the lightest traffic of all, and which was, apparently, the one most exposed to injury by the storm, was kept partly open, though trains were few in number, and the lower end of the line, for nearly two miles from the Battery, was not open at all. Such traffic as there was to be carried was consequently thrown entirely upon this line, with the result that the slender facilities it offered were so terribly overtaxed that it was difficult, if not dangerous, to attempt to reach the cars at all.

This result was hardly creditable to the management. By their position and construction the elevated lines are necessarily free from deep drifts or great accumulations of snow. The draw-back imposed by the same conditions is that the use of heavy engines or of several engines together is not possible. The stalling of trains was due, it is said, to the packing down of snow between the guard timbers which are placed on each side of the rails to prevent the wheels from leaving the road-bed in case of a derailment. This is very probable, but it also appears that the road is not provided with any snow-plows or sweepers of even the most elementary kind. The trouble which did occur was just that which might have been anticipated, but no provision had been made to meet it, and, for a time at least, no serious effort seems to have been made to remedy it. It may be noted also that the first attempt to run was made with full trains, no one apparently thinking of reducing the load in the storm.

The whole trouble seems to have laid in two points: a blind reliance upon the advantages of position, and the practice of cutting down expenses to the lowest possible point, without considering whether such reduction may be consistent with a true economy or not. This has always been the policy of the present management, and it is that which has brought it into such general disrepute among the people who see its results. It is true that the storm was one of very unusual violence; but there was hardly even a pretence of unusual effort to meet it.

On the second day of the storm, it must be admitted, the roads did better, all the lines being kept open after a fashion. The running of trains was very irregular, however, and it took more than 48 hours to restore the operations of the road to anything like their usual order.

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ONE of the results of the failure of the elevated roads has been a great increase in the disposition to favor new rapid transit projects, and especially the underground lines. While there has been a general talk of the necessity of some additional facilities for rapid transit in the city, the active work on behalf of the new schemes has been, for the most part, confined to those directly interested in the projects or in the development of property improvements through their construction. The average citizen talks about them, and recognizes that something should be done, but has not troubled himself to go further. Now, however, the imperfections of the present system have been presented in so direct and forcible a manner, that the feeling in favor of new lines has received an impetus that it might have required several years to gain under ordinary circumstances.

Most New Yorkers have had great faith in the elevated roads, however much they might grumble at them. They expect the surface lines to give out in a storm, but they have always really felt safe so long as they had the elevated to fall back on in case of emergency. Now this faith has been rudely shaken, if not destroyed, and it can never be fully restored. The tunnel projects have never, to tell the truth, been very popular in New York, and have never received, among the general public, that serious consideration which will now be accorded them.

It is true that some of this feeling and talk will necessarily die out as the memory of the occasion for them fades away, but much of it will remain, and will have weight in determining the result, and especially in aiding to raise money for an underground line, should one of the contending projects secure sufficient legal standing to permit the beginning of work. The elevated roads may have been too severely judged, but the fact remains that public confidence in them has been weakened to such a degree that it can never be fully restored.

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THE latest plan for rapid transit in New York is for an underground road to run through the blocks, not following the course of any streets. The projectors' plan includes the purchase outright of all the real estate needed to build the road, and they propose to utilize the land, after the tunnel has been cut through, by putting up on it buildings corresponding in general character with the neighborhood. Four tracks are proposed, with a system of branches connecting with the ferries and railroad stations. The originators of this plan claim that while the purchase of the property will necessarily require a very large sum, a large amount will be derived from the rents of the buildings to be erected by the company, through the cellars of which the road will run.

This plan has rather an attractive air, and may have in it the idea which is to furnish the city with the much-needed additional facilities for travel. In its present form, however, it looks very much as if a big real estate speculation was connected with it. It would be much better to drop the connection, and then more confidence in the company and its scheme, on the part of the people, would be felt.

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THE great amount of damage done to the telegraph wires in the East by the recent great storm, and the injury to business and personal inconvenience caused by the almost total suspension of telegraph service over a large section of country, furnish a strong argument in favor of underground wires. Heretofore the burying of the wires has been urged only in a few large cities where poles and lines have been multiplied to such an extent as to become an actual disfigurement to the streets, and a source of danger by interfering with the operations of firemen in case of a large fire. Now the necessity of underground lines through the country, at least to supplement the pole

lines in case of interruption, if not to take their place altogether, has had a practical illustration which has been very forcible in its results.

Electrical experts differ very much as to such lines, although the matter seems quite simple to outsiders. In London and elsewhere in England good results have been obtained from wires put underground in a very simple way, and it would seem possible that the same means would answer here, under a fair trial. That it is desirable to put the wires out of the way in large cities will be generally admitted, and it would seem also that the business interests which depend so largely on the telegraph were entitled to protection against such accidents and interruptions as those lately seen. Such protection could be secured by underground wires, and the cost of replacing the lines destroyed by a great storm like that of March 12 would go a long way toward paying for the change.

For railroads a wire protected against all injury from the weather would have especial value. No inconsiderable part of the trouble resulting from the storm was caused by the failure of the telegraph, which made it impossible to ascertain the whereabouts of delayed trains and prevented free use of the men and motive power assembled to clear the tracks.

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AN important bill was introduced in Congress at the commencement of the present session, by Senator Cullom, of Illinois, the object of which is to change entirely the system of conducting work on river and harbor improvements. As is well known, this work has been, from its very beginning, under the charge of the War Department, and has been conducted by engineer officers of the Army.

Mr. Cullom's bill proposes to organize a Bureau of Harbors and Water-ways which shall be entirely independent of the Engineer Corps and which shall have an organization complete in itself. This bureau is to have a Chief Engineer, a number of department or supervising engineers, and as many district and assistant engineers as may be necessary to conduct the work in hand. The first appointments in this service, under the bill, would be made after examination as to capability, somewhat on the plan of the Civil Service examinations, and the positions would be open to all engineers who may choose to apply for examination.

Provision for filling up the lower ranks of the bureau in the future is made by providing for the appointment of a corps of cadets, who are to receive the necessary practical instruction in the field, and to be eligible to permanent appointments, as vacancies occur.

This bill meets with favor from the Council on Public Works, which was constituted by delegates from a number of local engineering societies over a year ago. Should it pass, it is probable that it would be regarded only as a commencement, and that an effort will be continued to extend its provisions until the bureau is made to include all public works of the Government, with the exception of fortifications and other exclusively military works.

The bill appears to be somewhat incomplete in its provisions, as might be expected with a measure of this kind, providing for an entirely new system. It is open to criticism and comment, however, and it is not likely to pass for some time, if, indeed, it comes to a vote at all at the present session. It would seem that, if the change is to be made at all, it would be much better to make it complete at once and to organize a single department, which might control not only the river and harbor work, but all the engineering work carried on by the General Government, including the Coast and Geological Surveys, the construction of public buildings, and possibly other scientific work now in progress. Should such a department be organized, the first great difficulty would be to secure a competent head, and the next to prevent the lower ranks from being filled up by men who would secure their appointment by political influence rather than capability.

Possibly the department might not offer many attractions to ambitious young men, as after its first organization promotion would necessarily be slow; on the other hand, there would be the attraction of a permanent position and a retiring pension, both of which will be offered, should the organization be on the lines laid down in the present bill.

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OUR contemporary, the *American Architect*, recently published a report of a debate in the United States Senate which illustrated in a striking way the lack of system with which the business of designing and erecting our minor public buildings is carried on. The appropriations, in the first place, are made by Congress in a haphazard sort of way, and the work is then thrown upon an officer who is underpaid and overweighted with work. Under all the conditions it is no wonder that numerous abuses have crept in, and that fault is found on all sides. The proper remedy seems to be in a more efficient organization of the work and in the supply of sufficient help to enable the bureau to design and supervise the buildings ordered by Congress. It is, perhaps, expecting too much to hope that that body will ever be very careful in ordering work of this kind, or will preserve a due sense of proportion in its appropriations.

In this connection it may be noted that in many of our larger buildings, both public and private, it would be well if the engineer as well as the architect were called in. We do not by any means wish to disparage the ability of the many able men who are to be found in the architectural profession; but there are many questions which arise in the construction of large buildings which are purely engineering questions, and which a skilled engineer is certainly more competent to decide. Some past experience on railroad work shows that an engineer is very apt to make mistakes when he is called on to act as an architect—and the converse of this proposition may be true also.

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THE transfer of the Erie Express to the Wells-Fargo Company ends the last attempt made on a large scale in this country by a railroad company to conduct the express business over its own lines. Four important companies have made this attempt—the Delaware, Lackawanna & Western, the Philadelphia & Reading, the Baltimore & Ohio and the New York, Lake Erie & Western—and each in succession has given it up, and has transferred the whole business to one of the great express companies. Two of these companies have made the transfer under the pressure of financial necessity and as a condition of obtaining outside aid; the other two, apparently, because the experiment has not proved profitable, or because they could do better by the transfer. In the Erie case it has been done, most probably, because by it the company secures the large Western business which the Wells-Fargo Company could throw upon its line between Chicago and New York.

The Baltimore & Ohio experiment was continued the longest and most persistently. The Erie Express was started under favorable conditions, was well equipped and managed and apparently prosperous. It withstood an attempt by the express companies to crush it by cutting rates to competing points, and seemed to have reached a solid basis, and to be in a fair way to become a permanent part of the railroad organization.

In none of the cases has there been any detailed or careful statement of the results of this business made public, so that it is not possible to say whether it has been directly profitable or not. There are some obvious advantages in the conduct of the business by the express companies, while, on the other hand, it would seem as if a railroad company with a considerable mileage ought to retain for its stockholders whatever profit there may be in business of this kind. The actual carriage of the express freight over the railroad lines is simple enough, and a railroad company would probably secure much better rates for it by doing the business directly than by hauling it in bulk for an outside company. The organization for delivery and collection of packages in a great number of places, large and small, is a more complex matter, but still one that, it might be supposed, could bear ranged in such a way as to still leave a margin of profit for the company under proper conditions. That it does leave less than can be secured by turning the business over to an outside organization seems to be asserted by the new arrangement which the Erie has made.

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THAT "figures cannot lie" is an old adage so often quoted, that most of us have grown up with a sort of superstitious reverence for statistical tables, and an argument which is fortified by a mass of them is apt to be accepted without further question. A French scientific contemporary recently published an article on statistics which contains a very curious estimate of the amount of labor yearly expended by government employés and learned bodies all over the world in gathering up, tabulating, and preparing for publication vast masses of figures on all sorts of matters. Our contemporary goes on to say that these figures are duly printed, indexed, published, and distributed carefully to an expectant public, which receives them with all due reverence—but does not read them. A very few of the volumes thus put forth may be sometimes referred to; others find a resting-place on dusty shelves of libraries, where they are never disturbed, but the majority, alas! come finally to "our old friend, the chiffonier," and through him to the paper-mill.

There is a great deal of truth in this, and our contemporary is quite right in asserting that a large part of the labor to which it refers is really wasted. Most men, as we have said, have a certain reverence for statistics, but most men also do not care to read or study them. The few who do soon learn the melancholy truth that very little wisdom is expended in collecting the statistics of the world. The student who really understands the value of figures will soon find that they are very seldom gathered or presented in such form as to be really useful, and learns not only to regret the amount of time and work thrown away for the want of intelligent direction, but to distrust the value of statistics generally, and to believe that if figures cannot lie they can at any rate be made, either by design or ignorance, to most effectually conceal the truth.

## PATENTS AND COPYRIGHTS.

VERY strenuous efforts are now being made to secure the passage of an international copyright law, and thus put an end to the national disgrace which attaches to the fact that robbery of the production of intellectual labor is now legalized in this country. Whether the efforts which have been made to secure the passage of the bill now before Congress will succeed is now uncertain, although its friends are very hopeful of success. The adoption of such a measure would certainly remove the national disgrace which every right-minded and honest citizen of the United States should feel when he or she contemplates the attitude which we occupy in relation to this subject in our dealings with other nations.

The discovery and perfection of some of the new processes of engraving have made the need of international copyright more urgent than ever. By the aid of photography, it is now possible to reproduce, in an electrotype relief plate, a whole page of print, either of the original size or reduced to any desired scale, without setting any type at all. Of course such a copy is an exact duplicate and no proof-reading is needed, excepting to correct defects in the plates. This makes wholesale piracy cheaper, more profitable and more alluring than ever, and the freebooters of the great ocean on which authors launch their boats and ships have now a predatory equipment ready at hand. A piratical "trust" will probably be the next step, unless the American people grow weary and disgusted with the infamy of the whole business and adopt legislation which will finally "establish justice."

On one class of authors the absence of international copyright is especially hard. We refer to those who write on scientific and especially engineering subjects. The value and the labor in such writing is very often largely and not infrequently *chiefly* in the preparation of drawings and engravings to illustrate the subjects written about. With the aid of the new process of engraving, electrotype plates of these and the letter-press can be made, page by page, at a cost of a few cents per square inch, and the books—engravings and all—can be reproduced at only a very small fraction of the original cost. An American engineer who now devotes much time and labor to the preparation of illustrations and to writing a book can have the happy consolation that a foreign publisher may appropriate the results of his work and his knowledge, without leave or license, and reap the profit, and the author is helpless to prevent it. It is hard to see how such a condition of things will aid in developing the literature of engineering in this country. It therefore becomes all engineers to do all they can to secure the passage of the Chace bill now pending in Congress.

Some of the friends of international copyright are relating, with considerable glee, of the way in which a piratical publishing house, which need not be named, has been defeated in its ignoble purpose by the new process of reproducing electrotype plates. This house commenced the republication of an expensive foreign work by the ordinary method of type-setting. They met with one difficulty from the fact that the foreign publishers had a certain number of articles written by Americans and copyrighted in this country. Now the new process men have come along, and are reproducing this same work at about half the cost of the first reprint. How the second

band of—reproducers—will meet the difficulty of the American copyright has not yet appeared.

If the nature of the right of an author to the results of his own intellectual work were better understood, doubtless the injustice of permitting wholesale robbery of foreign authors would soon be ended, and steps would be taken to protect our own citizens from the depredations of publishers in other countries. For some reason, though, the average man seems to be slow in perceiving that if a person puts his ideas into words and makes an instructive or entertaining book, that he has as much right to the results of his labor as a cabinetmaker or a shoemaker has who produces furniture or boots. The mental difficulty in getting at a true comprehension of the rights of authors seems to be that persons are not able to realize that there can be property in a purely ideal thing. A pair of boots or a table is something material, and the maker's right to what he has produced is never questioned; but they are slow to understand why if a person with very great labor has arranged many thousands of words in such relations to each other as to express ideas, that he should be given the right to the "combination," to use the phraseology of the Patent Office. The labor involved in writing books consists in arranging the words so as to express the author's thoughts. His right is in that arrangement and it is that which the law should protect, no matter whether the author is a native or a foreigner.

In this country the right to a new invention is generally admitted and is recognized by the law. It is based, however, on quite different grounds from a copyright. "The patent system," says a distinguished writer on patent law, "proceeding on the policy of encouraging the exercise of inventive talent by securing to the inventor an original property which, without protection, would have rested only upon a principle of natural justice, takes notice of the exclusive right of that first inventor, and makes it effectual by assuming that he who has first exercised the right of invention has bestowed something upon society which ought to procure for him thereafter, at least for a time, the exclusive right to make that thing."

The essential element in an invention which gives the patent on it validity is its *priority*. The law says, unless you were the *first* inventor you have no rights which will be recognized; or it promises and grants monopolies, for seventeen years, to those who *first* discover a "new and useful art, machine, manufacture, or composition of matter." A *second* discoverer has no rights under the law. It is the element of *firstness*—to coin a word—in an invention which gives the right to a monopoly of it for a limited time.

This is not the case with books. No two authors ever write the same book. The element of priority has nothing to do with copyright. An author acquires a right to the work he has done by adding one word to another or by a process of aggregation, just as a bricklayer builds a wall by adding one brick to another. Having done this, the law of copyright recognizes his claim and says that no one else shall copy what has thus been laboriously put together. The injustice is in the fact that our law says, We will recognize your right to such an aggregation if you are an American citizen; if you are not, your rights will not be recognized. The injustice and the shame of it needs no further comment, or ought not to need any, to make it apparent.

## New Railroad Building.

COMPARATIVELY little active work on new railroads has been done so far this year; partly because the season has been very unfavorable for this kind of work, and partly because there is really less to do than there was a year ago. With the enormous new mileage of last year railroad building apparently reached its climax for the present, and this year, while it may see the addition of a considerable mileage to our railroad system, will probably not attain to the figures of 1887. It is true that new projects are continually brought forward and that the organization of new companies is continually recorded; but in most of the States it is so easy to form a company that a new corporation counts for very little, and only a small proportion of them succeed in transforming their paper locations into actual road-bed and track. There is room for new lines, well placed, in many parts of the country, but there is less disposition to build them.

There are several reasons which can readily be assigned for this. The amount of capital absorbed last year in railroad work was enormous, and while money is not scarce, the amount ready for investment in this kind of work has necessarily been much reduced. It will not be as easy as it was a year or two ago to secure capital for a new enterprise, and it is only companies of standing and established credit which will be able to get what they want without difficulty. This alone will put a considerable check upon extension, and a further one will be found in the higher prices resulting from a period of active demand.

There are fewer long lines of importance begun and to be completed this year than there were last year. Indeed, there are not many long lines now under construction, or likely to be undertaken at once, with much prospect, of success. The Chicago & Northwestern has been credited with the intention of pushing its line through to a new connection with the Pacific Coast, and one or two other similar projects might be named; but the companies concerned have as yet given no signs of their purpose to push work in such directions at present, whatever their plans for the future may be.

The present indications are that new railroad work during the present year will follow very nearly the lines of last year. Comparatively little will be done in the East, and there is no sign of a revival of the disposition to parallel existing lines there or increase the number of trunk lines, which was so prominent a few years ago. A good deal of work will probably be done in the Northwest in the way of branches into new country, connecting lines and the completion of existing systems. A great deal is promised also in the Southwest, where the building of branches and extensions and the rush to secure territory is to continue, apparently, though with somewhat abated speed. The greater part of this work will be done by existing companies, whose established credit gives them facilities for obtaining money which newer organizations do not possess. In the South there are a number of incomplete lines which may be expected to do something this year, but most of them will probably move slowly.

The evil effects of too great competition have so far developed themselves that a check has apparently been put on the building of new through lines in the country between Chicago and the Missouri River, and little will be done there except in the construction of short lines, for

which room may still be found. An exception may be made in the completion of one or two lines which are now so far on their way that they are sure to be finished this year.

The conditions, it will be seen, while promising a reduction from last year, will still admit of a very respectable total when the figures come to be reckoned up. Just how large the increase will be it is somewhat early to say, but a few months will develop the intentions of a few leading companies upon whose action the total amount of work will largely depend.

A reduction in the new mileage built, however, does not necessarily mean a period of dullness for all the industries dependent upon railroad building. New construction was so pushed last year that rails were laid in advance of the ability of the companies to equip the lines, and there is likely to be a demand for new locomotives and rolling stock for some time to come which will give plenty of occupation to builders, and cause a demand for material. The new lines are not always by any means finished when the rails are laid, and new material will still be called for in their completion and improvement. A prosperous year also is apt to be followed by liberal renewals and improvements on older lines. Altogether there are no indications of a dull year, and the prospects are that there will be work enough to be done to satisfy any reasonable expectations, though there may be considerably less extension of track.

## NEW PUBLICATIONS.

GEOLOGICAL SURVEY OF NEW JERSEY: ANNUAL REPORT OF THE STATE GEOLOGIST FOR THE YEAR 1887. Trenton, N. J.; State Printers.

The report of Professor George H. Cook, the State Geologist of New Jersey, for last year is brief, containing only a condensed statement of the work accomplished during the year. This is the case on account of the approaching completion of the work, and because it will soon be followed by the first part of the final report.

The chief work done last year was on the geodetic and topographical surveys of the State, with some investigations into water supply and drainage. The office work done was chiefly in the preparation of the final report.

The map accompanying the report this year comes up to the high standard of excellence which has always characterized the work of the Survey.

MONTHLY PILOT CHARTS: HYDROGRAPHIC OFFICE, UNITED STATES NAVY. Issued by the Navy Department.

These charts are in effect weather maps of the North Atlantic, containing a general summary of the meteorological conditions prevailing over the part of the ocean during the month which the chart covers, with as extensive a forecast as possible of the weather which may be expected during the following month. In compiling these charts information from every possible source is used, and much reliance is placed upon meteorological journals kept on shipboard and returned to the Hydrographic Office. Quite a large number of shipmasters are now interested in the work, and the number of such journals kept has been so increased as to make them valuable sources of information. Of course, the value of such observations increases very rapidly with their number, as an opportunity is given of comparing the work of observers at different points. In order to make the work as effective as possible branch offices have been established in all the principal seaports, from which these charts are supplied to those who desire to have them. Arrangements have also been made to loan standard meteorological instruments to all shipmasters who will agree to keep journals for the office.

The information given on these pilot charts includes attraction, force of winds; limits of trade winds; regions of rain; fog belts with their probable limits; ice and icebergs; position and character of wrecks; probable track of abandoned vessels; routes between leading ports; barometric observations; storm cards and directions in case of cyclones; and much other information of interest and value to mariners.

Weekly supplements are issued from the branch offices giving the weather conditions and other information relating to the Atlantic coast of the United States. It is proposed to extend the work, as opportunity offers, and the Hydrographic Office hopes in time to include the whole maritime world as well as the North Atlantic.

THE LOMB PRIZE ESSAYS ON PUBLIC HEALTH: AMERICAN PUBLIC HEALTH ASSOCIATION. Concord, N. H.; Published by the Association, Dr. Irving A. Watson, Secretary.

The American Public Health Association, an organization which has for its object the promotion of sanitary science, has issued, in pamphlet form, four papers which were selected by the committees of award as the best of a very large number presented in competition for prizes offered through the Association by Mr. Henry Lomb, of Rochester, N. Y. The subjects of these essays and their authors are as follows:

1. Healthy Homes and Foods for the Working Classes; by Victor C. Vaughan, M.D., Ann Arbor, Mich.

2. The Sanitary Conditions and Necessities of School Houses and School Life; by D. F. Lincoln, M.D., Boston.

3. Disinfection and Individual Prophylaxis against Infectious Diseases; by George M. Sternberg, M.D., Surgeon, U.S.A.

4. The Preventable Causes of Disease, Injury and Deaths in American Manufactories and Workshops, and the Best Means and Appliances for Preventing and Avoiding them; by George H. Ireland, Springfield, Mass.

The Association is desirous of securing for these essay, the widest possible circulation, and therefore offers them for general sale at a price simply covering the cost of production, No. 1 being furnished for 10 cents, the other for 5 cents each. They contain much valuable information, and a reading will well repay all who are interested in sanitary science, and that class should include all intelligent people. The paper on School Houses especially deserves the attention of all teachers and professional men. Dr. Irving A. Watson, of Concord, N. H., is Secretary of the Association.

For the current year, under Mr. Lomb's gift, the Association offers a first prize of $500 and a second prize of $200 for a paper on Practical Sanitary and Economic Cooking Adapted to Persons of Moderate and Small Means. The conditions of the competition may be ob-

tained from the Secretary, in whose hands all papers should be placed by September 15 next. The awards will be announced at the next annual meeting of the Association.

## BOOKS RECEIVED.

HARPERS' WEEKLY for March 10 has a very interesting article on the "Defense of Our Ports," by Brevet-Major J. P. Sanger, U.S.A. It is well illustrated, the engravings showing modern guns and gun-carriages, and also the proposed iron turret system of defensive works.

PHOTOGRAPHY AS APPLIED TO SURVEYING: BY LIEUTENANT HENRY A. REED, U. S. A. New York; John Wiley & Sons (price, $2.50).

SIXTEENTH ANNUAL REPORT OF THE WATER-WORKS, BAY CITY, MICHIGAN: E. L. DUNBAR, SUPERINTENDENT. Bay City, Mich.; Tribune Printing House.

IMPERIAL UNIVERSITY OF JAPAN (TEIKOKU-DAIGAKU): CALENDAR FOR THE YEAR 1887–88 (XX–XXI YEAR OF MEIJI). Tokyo, Japan; published by the University.

PROFESSIONAL PAPERS OF THE CORPS OF ROYAL ENGINEERS, VOLUME XII, 1886: EDITED BY MAJOR FRANCIS J. DAY, R.E. Chatham, England; published by the Royal Engineers' Institute.

THE CONSTRUCTION OF MAPS IN RELIEF: BY JOHN H. HARDEN AND EDWARD B. HARDEN: ILLUSTRATED. Authors' Edition. Mr. J. H. Harden is Mining Engineer of the Phœnix Iron Company and Mr. E. B. Harden is Chief Topographer of the Pennsylvania Geological Survey. Their paper was originally read before the American Institute of Mining Engineers, and the reprint is accompanied by several illustrations showing their methods of work, and by a photograph of a relief map of the Cumberland Valley in Pennsylvania—a very beautiful piece of work.

MINERAL PRODUCTS OF THE UNITED STATES, 1882–86. Washington; Government Printing Office. The United States Geological Survey has issued a table, arranged by Mr. David L. Day, Chief of the Bureau of Mining Statistics, which shows the quantity and value of the mineral products of the country for the calendar years 1882 to 1886, inclusive. This table is in large type and printed on a large sheet, and is exceedingly convenient for reference and office use.

TWELFTH ANNUAL REPORT OF THE RAILROAD COMMISSIONERS OF THE STATE OF MISSOURI: JAMES HARDING, WILLIAM G. DOWNING, JOHN G. BREATHITT, COMMISSIONERS. Jefferson City, Mo.; State Printers.

TENTH ANNUAL REPORT OF THE BOARD OF RAILROAD COMMISSIONERS OF THE STATE OF IOWA, FOR THE YEAR ENDING JUNE 30, 1887: PETER A. DEY, LORENZO S. COFFIN, SPENCER SMITH, COMMISSIONERS. Des Moines, Iowa; State Printers.

THE PUMP CATECHISM: BY ROBERT GRIMSHAW, M.E.; ILLUSTRATED. New York; the Practical Publishing Company (Price, postpaid, $1).

ACCIDENTS IN MINES: BY SIR FREDERICK AUGUSTUS ABEL, C.B.; WITH ABSTRACT OF DISCUSSION ON THE PAPER. London, England; published by the Institution of Civil Engineers.

MECHANICAL DRAWING: BY LINUS FAUNCE. Boston; W. J. Schofield. This is a brief treatise which was prepared especially for the use of the students of the Massachusetts Institute of Technology. The object appears to have been to present the subject fully and at the same time in the most condensed form possible.

PREPARATORY TRAINING FOR SCIENTIFIC AND TECHNICAL SCHOOLS: BY CHARLES D. MARX, C.E. This is a reprint of a paper read before the Sigma Xi Society at Cornell University, by the Author.

REPORT OF THE STATE BOARD OF HEALTH OF MASSACHUSETTS ON WATER-SUPPLY AND SEWERAGE, JANUARY, 1888. Boston, Mass.; State Printers.

THE ERIE CONTINUOUS STEAM-HEATING SYSTEM. Erie, Pa.; issued by the Erie Car-Heating Company.

MANUAL OF THE PRINCIPAL INSTRUMENTS USED IN AMERICAN ENGINEERING AND SURVEYING: TWENTY-SEVENTH EDITION. Troy, N. Y.; W. & L. E Gurley. This is the twenty-seventh edition of the catalogue issued by this old and well-known house; it contains much valuable information in addition to the ordinary catalogue matter.

THE BENTLEY-KNIGHT ELECTRIC RAILWAY: DESCRIPTION AND ESTIMATES. New York; issued by the Bentley-Knight Electric Railway Company.

# Contributions.

### Melting and Freezing Points.

BY PROFESSOR DE VOLSON WOOD.

WHEN ice and water are mixed, the highest temperature at which the ice will remain solid is the same as the lowest temperature at which the water will remain a liquid. At the pressure of one atmosphere, this point is not only common both to the ice and water, but is believed to be a fixed point.

But it is an interesting fact that if pure or distilled water be placed in a glass vessel and kept perfectly quiet while it is subjected to a cold atmosphere considerably below ordinary freezing, the temperature of the water may be reduced several degrees below 32° F. before it will freeze; and if the glass be jarred very slightly by a tap of the finger when the water is a liquid at a temperature below 32° F. ice will be instantly formed. This fact is not only known to science, but the experiment has been made at the Stevens Institute. Under these conditions water appears to possess the ability of maintaining its state of aggregation to a limited extent, but the condition is one of unstable equilibrium, for the slightest disturbance produces a change of aggregation. On the other hand, so far as known, the temperature of melting ice is a fixed point, at a fixed pressure. The kinetic energy of the molecules, supposed to be increased by the action of heat, prevents the condition of indifferent equilibrium. When an experimenter desires to determine the temperature of a liquid very accurately he gently stirs the liquid before reading the thermometer; and, if a magnifying glass be used, it will be observed the reading of the thermometer is not the same before the liquid is stirred as after.

## THE PRINCIPLES OF RAILROAD LOCATION.

By Professor C. D. Jameson.

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(*Continued from page* 110.)

### CHAPTER XV.

### THE TOPOGRAPHER'S WORK.

The outfit of the topographer consists of a thin drawing board 21×26 in., on the back of which is a waterproof pocket and a flap, both the size of the board. In this pocket are carried the sheets, 19×24 in., upon which the work is to be plotted. He must also have a small paper scale, pencils, rubber, thumb-tacks, etc.

Figure 1.

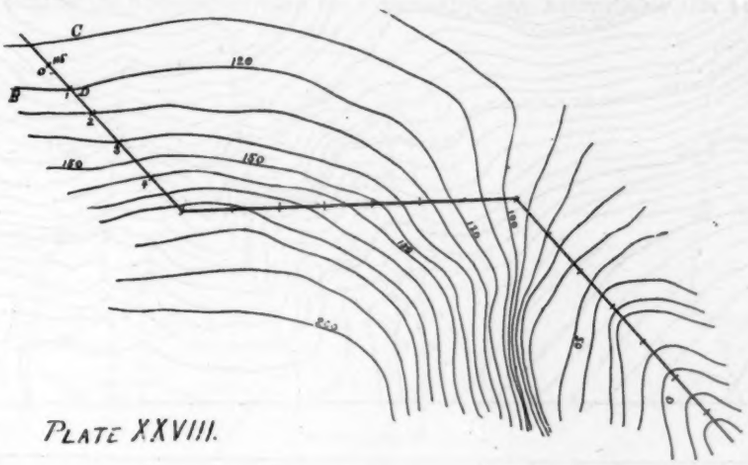



Plate XXVIII.

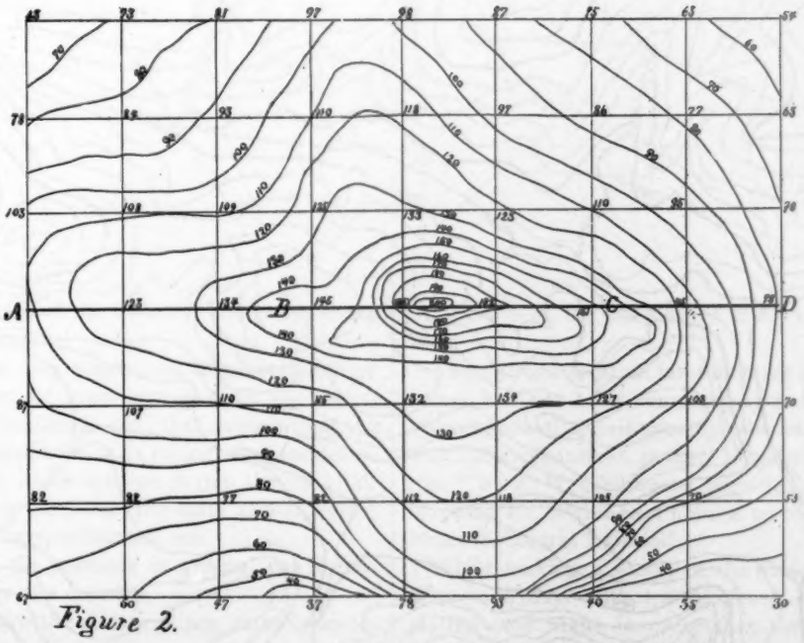



Figure 2.

The sheets should be of a light green color, if possible, as working in the sun on white paper is very bad for the eyes. The assistants have a tape-line, hand level (which may be used to advantage under some circumstances), and a small hatchet, besides the rods or clinometer and board rod.

On the sheets which the topographer has he plots the line as run by the transitman, and at each station the elevation, as given by the leveler, is lightly penciled.

The head assistant has the elevation of each station, and commences by measuring off, by means of the rod, to the contour next below or above the station, as in Plate XXVIII, fig. 1.

Commencing at station 0, which has an elevation 115, he finds the point *B* of the contour 120 and the point *C* of the contour 110. The topographer, taking these distances, plots them at once, and by his eye puts in a short piece of the contour. The assistants also give the points wherever the contours cross the main line, as contour 120 crosses the main line at *D*.

The topographer then moves ahead one or two stations, and, getting the points of the different contours, works backward to connect with what he had before, and sketches in very lightly the supposed direction of the contours in advance.

He should keep notes of the readings of the rods or clinometer, but merely as a check on his work, as the lines should all be accurately plotted in the field.

The most convenient scale for railroad work in an ordinary country is 200 ft. to the inch, and in a rough

country 100 ft. to the inch. Much time is lost by trying smaller scales, such as 400 or 600 ft. to the inch, and also much is lost in accuracy.

PLATE XXIX.

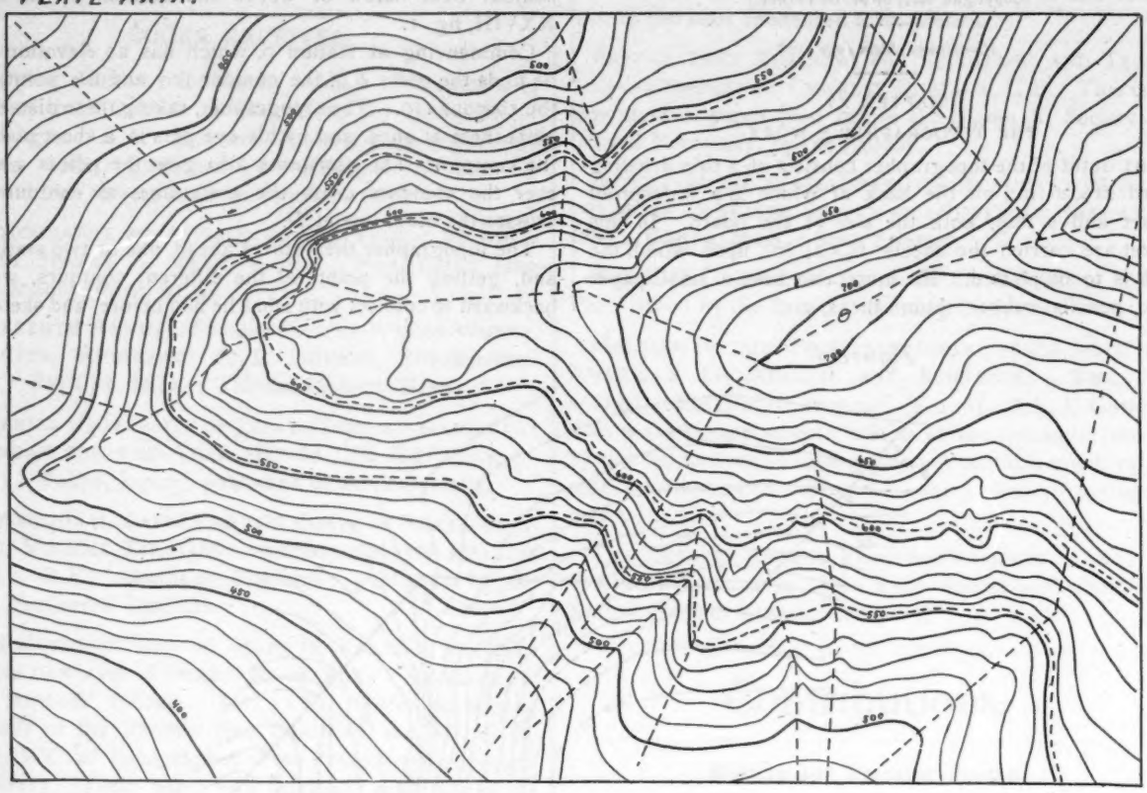
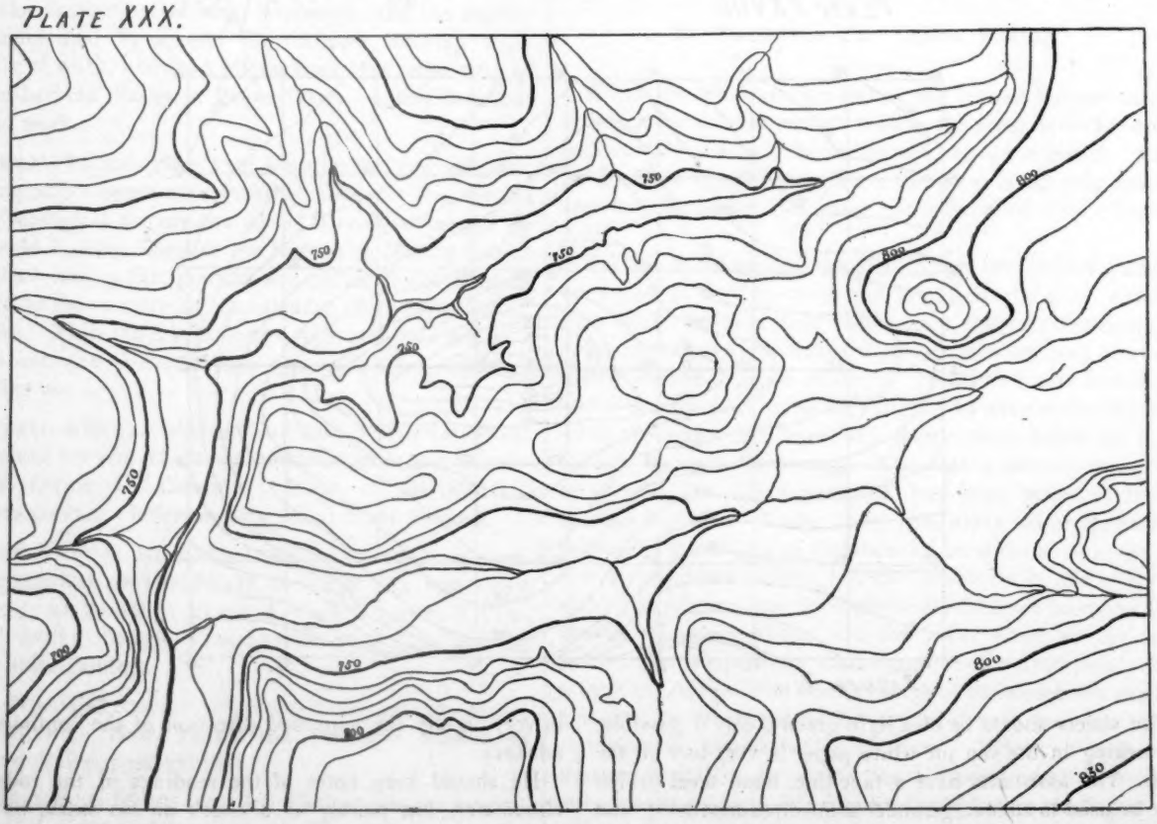


PLATE XXX.



The work of the topographer is slow if it is accurate, and unless accurate is worse than nothing. In it, as in every branch of the survey, much depends on the person. With practice and a quick eye the work can be kept well up with the other parties.

When the distance each side of the main line that is to be surveyed for contour lines is more than 200 ft., it is often more saving to time and conducive to accuracy to cross-section it with a wye level in the following manner

(Plate XXVIII, fig. 2): Let the plate represent a broad belt of country which it is desired to make an accurate contour map of. *A B C D* is the transit line. Then from every second or fourth station, according to the character of the country, run offset lines, at right angles to the main line, with either the transit or a surveyor's compass, and take the elevation of the stations on these lines with the wye level. All of these lines are then plotted and the elevation of each station lightly penciled in, and the contours then worked out from these elevations. It will be seen that any way the work is done it is a slow, tedious job, but when done accurately and the belt of country contoured is not too wide, it is money well spent for the railroad company.

The width of the country taken in should include any possible changes between the preliminary line and the final location.

The amount of detail taken by the topographer must depend upon the character of the country, and is left to the judgment of the engineer.

The topographer not only obtains the data necessary for the contour lines, but he must also plot all the watercourses, line fences, buildings, etc., that come within the boundaries of the strip of land he is taking, also the different kind of land over which the line is run, the material, whether earth, rock, or hard-pan, the state in which it is, whether wooded, swampy, cultivated, etc.

We have described the methods in general use for obtaining the topography of a country.

Those methods where the distances are actually measured, such as with the clinometer or cross-section rods, are called cross-sectioning, and can only be used for comparatively small distances.

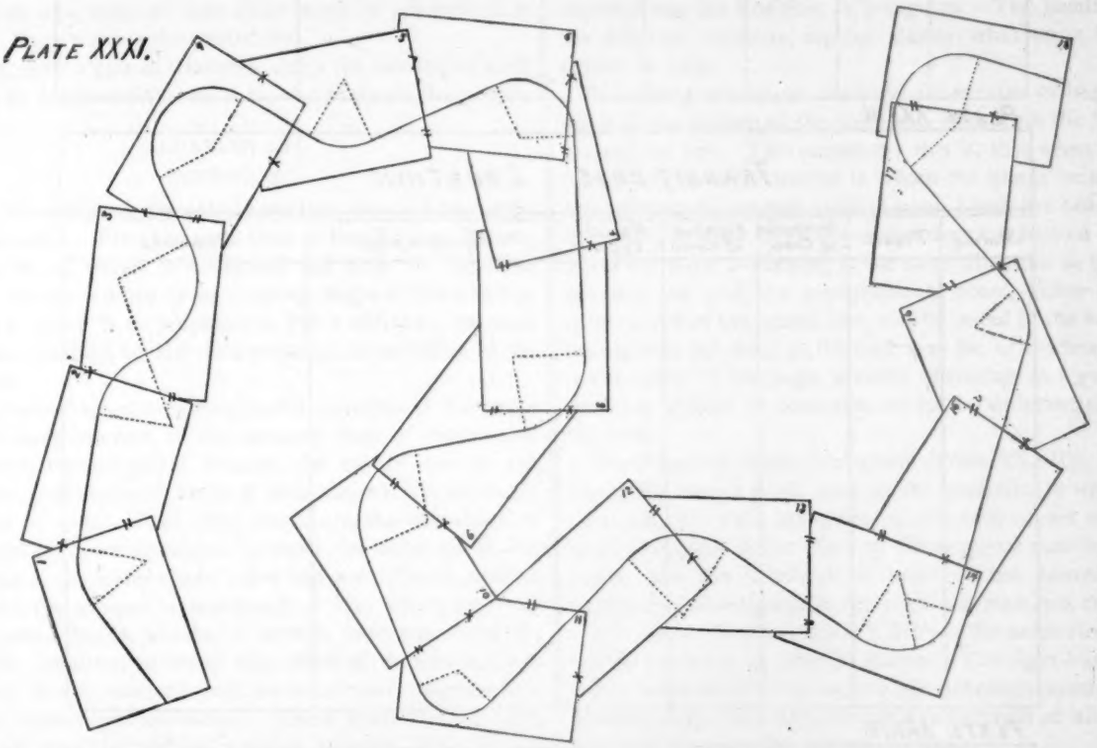
The quickest and most satisfactory method of all is by the use of the stadia, which has been fully described in the preceding chapter.

There is still another method used for obtaining a contour map of the country, and this is used when the extent of the country which it is desired to contour is so great as to practically exclude the use of the cross-section rods or clinometer, or the dividing of the country up into parallelograms and taking the elevation of the corners.

This manner of proceeding is to run lines with either a transit or compass over all the prominent topographical features, such as up the ravines, on the crests of the ridges, and, in fact, as nearly as possible over all points where the contour lines will make sudden changes in direction. Plate XXIX well represents this method of making a contour survey. The lines that would have to be run on the ground, in order to procure sufficient data to make the map, would be about where the dotted lines are, with the contours about 10 ft. apart vertically.

As a matter of fact, Plate XXX was taken from a map made for the actual location of a railroad line, in which the contour lines, as represented here, were 32.8 ft. apart vertically; the contours of the original map were put in every 6.56 ft., only every fifth contour having been kept.

PLATE XXXI.



The railroad location for this piece of country (the line, as yet, has not been constructed) was a most wonderful combination of spirals upon spirals, and is shown in detail, with full explanations, in the "Economical Theory of Location," by A. M. Wellington, page 684. The location was made by Mr. Wellington himself on the Pacific Line of the Mexican Central Railroad.

While making a survey in the field, all the work that is done each day, with transit, level, or stadia, should be plotted each night, in order that the Chief of Party can decide whether any of it must be done over again or whether the work shall go ahead.

The transit line should never be plotted on a long roll of drawing paper, unless there is very little curvature or topography. The reason of this is that it is extremely awkward to carry, and requires a large table upon which to spread it for plotting, and when there is much curvature in the line it is continually running off the paper. The

PLATE XXXII.

| TRANSIT-BOOK. | | | | | PRELIMINARY. | |
|---|---|---|---|---|---|---|
| Station. | Points. | Description of Angle. | Calculated Course. | Magnetic Course. | Topography. | Remarks. |
| | | | | | | |

PLATE XXXIII.

| TRANSIT-BOOK. | | | | | LOCATION. | |
|---|---|---|---|---|---|---|
| Station. | Points. | Description of Curve. | Elements of Curve | Magnetic Course. | Topography. | Remarks. |
| | | | | | | |

PLATE XXXIV.

| LEVEL BOOK. | | | | | | |
|---|---|---|---|---|---|---|
| Station. | + Sight. | Heigt of Instrum't | − Sights. | Elevation. | B.Ms. & T.Ps. | Remarks. |
| | | | | | | |

only proper way to plot an ordinary line in the field is to plot it on separate sheets, about 19×20 in. These sheets are added, one after the other, as the work progresses, the axis of each sheet being placed so as to make it coincide as nearly as possible with the center line of the survey. Each sheet laps under the preceding one, and at the edge two or more crosses—× × ×—are made, in order that they may be fitted together again in the same actual position. Plate XXXI. shows a number of these sheets put together, giving the line as laid down.

While these sheets are being worked upon, they are pinned down to the drawing-board with ordinary thumb-tacks. The size of the drawing-board is only large enough to pin down two or three sheets at a time.

Each sheet should be numbered in the corner, and should have a north-and-south line laid upon it.

In plotting the work a large paper protractor is laid upon each sheet, on the north and south line, over a permanent center and pinned down. The bearings of all the lines that will come on that sheet must be pricked off at once. Then remove the protractor.

Then, with a pair of triangles, carry the bearing of each line to its proper point, run it in, and scale off the length.

## CHAPTER XVI.

## NOTE-BOOKS.

The following are the note-books that are used on a railroad location. First the note-book of the Chief of Reconnoissance, in which is contained not only all the data which he can obtain from existing maps of the country through which it is proposed to run a railroad, but also the data obtained by him in a personal examination of the country.

This note-book should contain full sketches of the country, showing courses of the streams, lines of mountains, and other topographical features, the rate of flow of the streams, together with notes of their size and the probable amount of water which they discharge, the elevations of the different dividing ridges between the water-sheds and the area of the water-sheds; also copious notes as to what material the ground is composed of over which the road must pass—that is, whether it is rock, hard-pan, or earth, also the condition in which this material is, whether it is swampy or dry, covered with wood or clear, whether barren or under high cultivation. There must also be notes as to all possible bridges, trestles, tunnels, etc. In this respect notes can only be made as to the more important structures, as the smaller ones are only developed on the preliminary survey. There should be notes on all the resources of the country, both developed and undeveloped—that is, the resources as they actually exist at the time of the reconnoissance, and the resources which, by the introduction of the proper means of transportation, may be developed into paying business, and furnish traffic for the road.

As we have said, the future financial success of a new railroad depends not so much on the present traffic or the traffic which exists at the time the road is built, as upon what the future traffic will be. Therefore, the future traffic is one of the most important things which is to be studied.

There should be notes as to the different classes of resources; whether it is a mineral country, an agricultural country, or whether, owing to the presence of great water-power, it may become a rich manufacturing country.

All these notes should be as full and explicit as possible, nothing being left to the memory of the Engineer. Always, on a reconnoissance, the Engineer should carry another small note-book in which to keep notes of the barometrical readings used in obtaining the elevations of the various points; the readings of the hand-level should also be kept in this book. Barometrical readings, after a reconnoissance, should be all worked out and corrected, and the results copied into the regular note-book of the reconnoitring engineer.

The TRANSIT BOOK, PRELIMINARY LINE, should be of convenient size to carry in the side pocket of the coat, have stiff covers, and be ruled as shown in Plate XXXII, which represents two pages of a transit book. The right-hand page (not shown), in addition to having a heavy line in the center, which is usually in red, is divided by vertical lines, eight or ten to an inch, which serve as a scale when sketching any features of a country, on each side of the center line.

This heavy line in the center is always considered as representing the line that is being run. The headings of the different columns explain clearly what must be recorded in each.

In keeping transit or compass notes, always begin the notes at the bottom of the page and work from the bottom toward the top. The reason for this is, that when in the field facing in the direction in which the line is being run, and holding the transit book in your hand, the heavy line on the right-hand page, running from the bottom to the top of the page, is running in the same direction as the line is being run, and any topographical notes, either on the right or left of the actual line, can be noted in the book on the right or left side, as the case may be, of the heavy line in the center of the page, thereby obviating, to a great extent, any chance of confusion as to the different sides of the line.

The TRANSIT BOOK, LOCATION (Plate XXXIII), is similar to the transit book used on the preliminary work, the principal difference being that in this case curves are used to join tangents in the place of the tangents meeting at an angle, and the headings of some of the columns are changed to accommodate the required elements of curve.

The LEVEL BOOK (Plate XXXIV) is the same size as the transit book, and is ruled as shown. The right-hand page is left blank in order to receive any necessary remarks and descriptions. It is here that full description of all bench-marks and permanent points are made.

The headings of the different columns may be either as in Plate XXXIV or in Plate XXXV, both forms being much used and very convenient; some engineers prefer one and some the other.

The older form of keeping level books, where plus and minus readings are put in the same column, with proper signs prefixed, is now obsolete.

RELOCATION NOTES (Plate XXXVI) are prepared from the plans of the preliminary line and the contour maps which have been made. The line is located on paper and then the proper notes prepared, showing the alignment of the lines to be run in on the ground. These notes serve more as a guide than as the actual notes of a line which must be run whether it fits the ground or not upon trial, because, no matter how exact the contour map is made from the notes taken on preliminary survey, it is impossible to make a paper location in the office that will actually be the best line that can be run on that ground, and where it is not the best line and the points where it is to

PLATE XXXV.

LEVEL BOOK.

| Station. | + Sight | Height of Instrument | − Sight. | Rod. | Elevation. | Remarks. |
|---|---|---|---|---|---|---|
| | | | | | | |

PLATE XXXVI.

TRANSIT-BOOK RE-LOCATION.

| Station. | Alignment. | Central Angles. | Length. | Magnetic Bearings. | Topography. | Remarks. |
|---|---|---|---|---|---|---|
| | | | | | | |

PLATE XXXVII.

CROSS SECTION BOOK.

| Station. | Surface | Grade | Cross Sections. | | Excavations. L. Rock. | S. Rock. | Earth. | Embankment. | General notes. |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |

be corrected to adapt it to the surface of the ground can be easily seen and must be changed in the field.

The CROSS-SECTION BOOK is shown in Plate XXXVII. The headings of the different columns show so clearly what is to be recorded in the columns that no other explanation is needed.

The form of the STADIA NOTE-BOOK was fully explained on page 107 (March number).

All of these notes should be guarded with great care and duplicates of them made as soon as possible, as they are the official record of what work must be done, and the only record whereby any calculation can be made as to the amount of work that is to be done at any time.

### CHAPTER XVII.

### THE OFFICE FORCE.

In keeping notes of the work done in the field the utmost care should be used that all notes of the same kind should be kept in exactly the same manner—that is, all the transit notes should be kept in the same manner, and the same letters should in every case be used to denote the same thing. The object of this uniformity is that although the notes are all worked out and plotted in the field, these original note-books are all sent into the main office, and there plans made from them by draftsmen who have never been in the field and know absolutely nothing of the work, in many cases, except what they see in the note-books.

Unless the notes of all the different engineers are kept with perfect uniformity much time is lost in studying out the different methods used, and the danger of inaccuracy in plotting is very much increased. One rule, which the Chief of Party should fully impress on all those working under him who are taking notes, is this perfect uniformity of methods, and he should not only impress this rule, but should know that it is obeyed in all cases and that the notes are full and explicit.

No engineer should ever trust to his memory for any facts in regard to a survey which he is making which may at any time, as far as can be foreseen, be of any use.

The draftsman who makes the plans of the work done in the field has nothing but the note-books to guide him, and unless these notes are full, plain, and explicit in every detail, the plan made from them will be absolutely worthless. These notes should be full and explicit, also, because they form by far the most valuable record of the work done. All the original note-books should be carefully preserved, and as soon as they are sent in to the office copies should be made of them in ink, and then the original note-books and the copies should be filed away in fire-proof safes, in separate places. These duplicates should be made by one person and checked by another.

In all engineering work it is a good plan to have all calculations checked by some person other than the person originally making them.

Of course the number of persons employed in the main drafting office of a railroad depends entirely upon the amount of work which is being done and the speed with which the work is being pushed.

There should be a Head of the Office, who reports directly to the Chief Engineer, and who is responsible for the amount and character of all work done in the office. He should be a competent engineer, who has had some field practice, a good draftsman, and have sufficient executive ability to command order and have the proper amount of work done in the desired manner.

There should be one bridge expert, who can calculate quickly and correctly what will be needed for the different bridges, trestles, etc. He should be able to check any calculations sent for consideration by the different bridge companies who may be bidding for the work, and he should have had some practical experience with some bridge company in designing and erecting the work.

There should be one man who understands architecture for the designing of station-houses, freight-houses, shops, etc. Also one or two who thoroughly understand plotting from field notes and calculating quantities. Lastly, there should be one man who is in every way a finished draftsman for finishing up in an artistic manner any map upon which it is deemed advisable to put this extra amount of work.

There should be one or two young men for making tracings, copying notes, etc., and a boy to attend to the blue prints or whatever reproducing process is used.

The above list of employés is not meant to give an idea as to the actual number that should be employed in any one case, but simply to give some idea as to the work which is to be done in the main office.

On some roads where the work is being pushed slowly and there is not much of it, one man, or at most two, may embody all of the above requisites, while on the other hand, on large works which are being pushed rapidly, there may be required several men to fill each of the above positions, with the exception of the Head of the Office.

(TO BE CONTINUED.)

## HYPERCYCLOIDAL GEAR.

By ALOHA VIVARTTAS.

THE principal characteristics of the gear teeth formed upon the hypercycloid are that while having the quality of perfect interchangeability—that is, gear of all the different numbers of teeth running together equally well—they not only fill their engaging spaces upon the pitch line, but also to the point of the tooth, making when on the line from center to center of the gear an absolutely close fit, as shown in fig. 1.

This gives fully 25 per cent. more strength than any other form of tooth of equal pitch and face by the additional material left at *a a*. It also gives 50 per cent. more wearing surface than other forms, since the part *b* runs smoothly against the whole surface from *a* to *c*.

This curve, as its name implies, is one of the cycloidæ, but to describe it in the ordinary manner, the scribing point is made to project beyond the rolling or generating circle, and the curve is scribed across the generatrix or pitch line; the portion of such curve used being mostly on the farther side of the pitch line from the generating circle, for a gear tooth from pitch line out works beyond or within the pitch line of the engaging gear.

On examining fig. 1, it will be seen that both the form and also the dimensions of both the tooth from pitch line outward and the space from pitch line inward in which it works are identical; and as this must be so in all cases, without regard to the number of teeth in either wheel, it follows that the cutter or template that would make the space from pitch line in for one wheel would be correct for all wheels of that pitch from pitch line in. And again, a cutter or template fitting the tooth from pitch line out would likewise fit the tooth of every wheel of that pitch.

This is the fact, and a male cutter cutting the spaces *a a c c* with a female cutter finishing the teeth *b b c c*, each working true to radial center line, as shown in fig. 2, is the practice in the shop.

The propriety of thus considering the tooth from pitch line out, independently of the space between the teeth

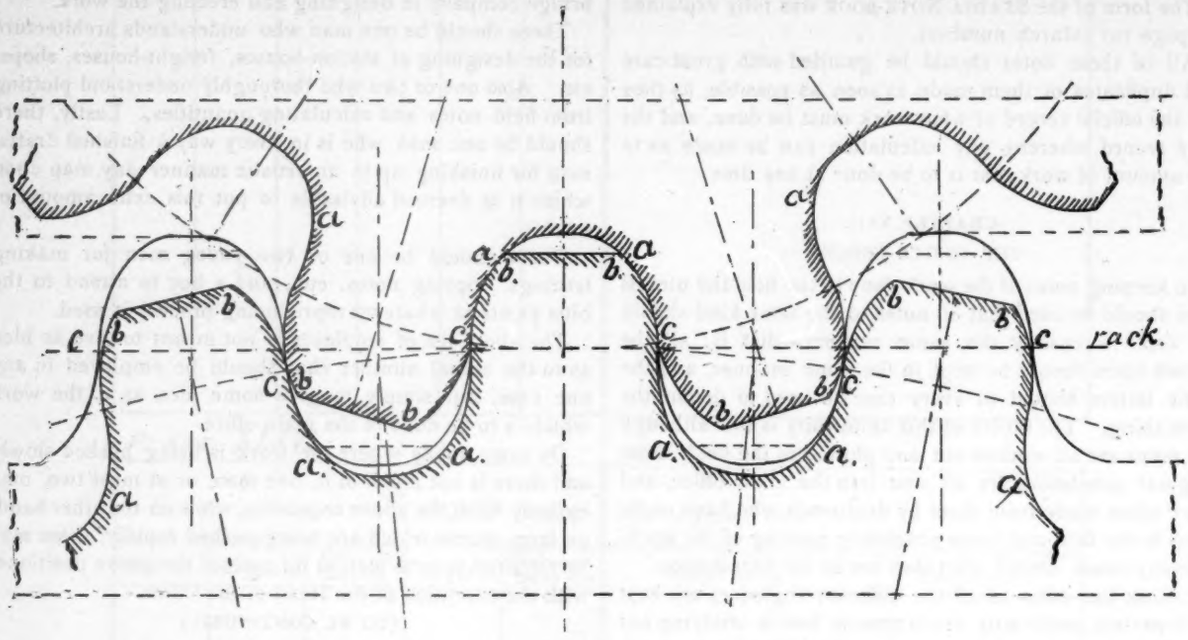



Fig. 1.

from pitch line in, is apparent by referring to fig. 3, which illustrates a method sometimes practised for equalizing the strength of the teeth in wheels of different materials, as wood and iron. In this case it is seen that a tooth of 1 in. pitch (as commonly considered) on one wheel may run

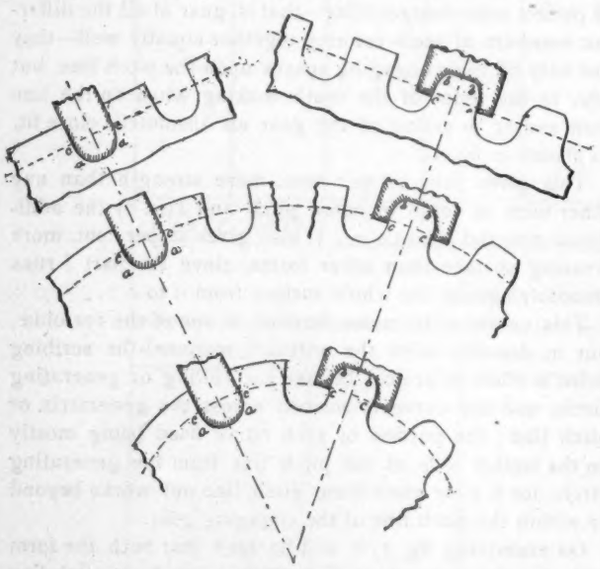


Fig. 2.

with a tooth of $\frac{1}{8}$ in. pitch upon the other wheel, giving a resulting pitch of $\frac{1}{4}$ in.; yet the wheels will run as perfectly as if the teeth were all alike. Observe that the teeth of either wheel project beyond their pitch lines according to their own size only, and wheels of this kind with equal numbers of teeth show different outside diameters.

This is generally an especial tooth, but admits of the principle of interchangeability so far that any wheel of the major tooth will run with any wheel of the minor tooth, and *vice versa*. This has also been done with worms and their gear.

In making internal gear, the principle illustrated in fig. 3 is applicable with good effect, but the best practice is to make the internal gear with only spaces within the pitch line, and omitting the teeth that would project beyond the pitch line entirely, as shown in fig. 4. In this, the pinion may be made especially for such gear, as *h*, with only teeth from pitch line out, and no spaces within the pitch line; or the pinion like *i* may be of the ordinary standard

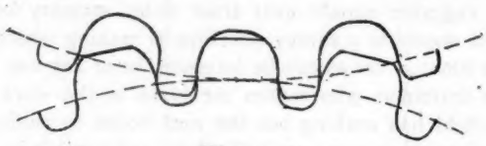


Fig. 3.

and run with other gear if desired. Either will run perfectly smooth and without backlash.

In the case of elliptic gear the same general principles apply, and the fit, strength, wearing surface, and smooth-running qualities are all maintained, due care being taken to cut each tooth true to its center line, which is not to be mistaken for the line from such tooth to the center of the gear, but which varies therefrom according to the location

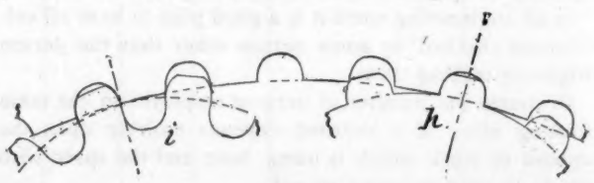



Fig. 4.

of the tooth, the extreme distance between the intersection of the center line of tooth or space, with the transverse diameter of the ellipse, being a third proportional to the distance between the foci and the length of the transverse diameter.

Such center line for any one tooth or space is easiest

found as shown in fig. 5. Draw a line from the center of the tooth on the pitch line to each focus, bisect the angle at the center of the tooth, and cut on such resultant, which is perpendicular to the tangent of the ellipse at that point, and consequently, as two elliptic pitch lines touching each other have a common tangent at the point of contact, the tooth on one pitch line will fit fair in the space within the other.

In chain or sprocket wheels, the chain generally works to the wheel as the extreme of the tooth of a rack, as *b b*,

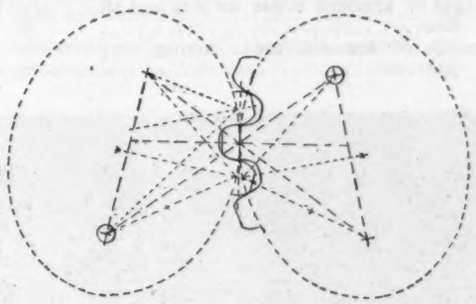


Fig. 5.

fig. 2, and as the chain works to the one side of its natural pitch line so the wheel is entirely, or nearly so, within its own pitch line, and shows little but spaces within the same, and no teeth proper.

In worm gear the section of the worm is the counterpart of the rack ; the gear is turned exactly the proper diameter

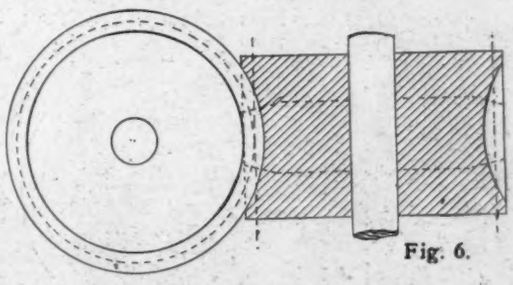


Fig. 6.

for a spur of the same pitch and number of teeth, but should never be hollowed to follow around the barrel of the worm, as all such excess of diameter interferes with its proper action, and causes the center of the tooth to undercut in making or wearing, weakening the tooth and doing no good. But a straight cylinder with the worm cutter driven into it just the depth of the tooth and space, as in

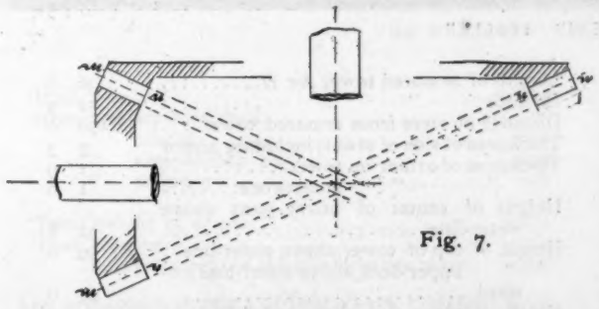


Fig. 7.

fig. 6, gives the strongest, smoothest-running and most durable results, as well as being the easiest to make.

In bevels of every description the hypercycloidal curve gives the same advantages as in spur gear. But the best bevel gear is made as in fig. 7, with the teeth and spaces as deep at *m* as at *n*. The advantages of this are that the gear are always working the whole length of the face from *m* to *n*, whether running exactly on pitch distances or not, while any wear of the journals does not throw the labor on the outer end of the teeth, as in the conoidal pattern, unless the angle of the shafting is changed. This gives greatly augmented strength and durability with the same weight of metal.

These gear are easier to make correctly than the conoidal tooth, and with the same tools will fit as closely and perfectly throughout from *m* to *n* as spur gear.

## THE ITALIAN BATTLE-SHIP "ITALIA."

(From the London *Engineering*.)

THE accompanying illustrations are a general view of the Italian armored ship *Italia* and a view of the upper deck, or top of the casemate. This vessel has aroused more interest in naval circles than any other warship since the French *La Gloire*, which was the means of introducing armor-plating as a method of defense for first-class ocean-going war vessels. This, we think, may safely be said without even excepting our own *Inflexible*, and the protracted inquiry and controversy which resulted from the strictures pronounced on that abundantly discussed ship.

The *Italia* and her sister ship, the *Lepanto*, were commenced about 10 years ago. In design they were an immense step on anything that had preceded them. Whether the step was in the right direction or not is a very much disputed point, on which many of the highest authorities in the science of naval construction all over the world hold diametrically opposite opinions. But one cannot help admiring the courage of the Italian naval authorities in laying down these two vast and costly ships, comprising so much in their design that was open to criticism and necessarily involving features of doubtful advantage. This reproach, however, may be brought against all modern warships, for the absolute data we have to go upon in the present day is of so meager a character that no one can pronounce with any degree of certainty what would be the practical fighting value of any particular class of design. Until the world sees a great naval war every one is entitled to an opinion, and hence the vast gulf that divides the doctrines of our most renowned professors.

The *Italia* was built at Castellamare, on the Bay of Naples, and the *Lepanto* at Leghorn. It will be remembered that in 1877 the Italian Parliament sanctioned what may truly be described as a spirited naval policy. It was decided to build 16 battle-ships of the first class, 10 of the second class, and 20 cruisers. Italy had then afloat the powerful armor-clad *Duilio ;* and her sister ship, the *Dandolo*, was being pushed forward at Spezia. These are iron ships, each 10,400 tons, of the *Inflexible* type, having turrets placed in a similar position to those of the latter vessel, while the ends depend on subdivision and on an armored deck for protection from fatal damage. The Italian vessels were commenced before the *Inflexible*, and, therefore, cannot in any way be said to have been copies of the English ship. In them external armor is placed on a citadel 107 ft. in length and descending for about 6 ft. below the water-line. This central distance of 107 ft. is the only part of the ship's side which is protected by vertical exterior armor. A design based on these lines soon attracted hostile criticisms from Sir Edward Reed, who, during the construction of the vessels, expressed his opinion that they were exposed " beyond all doubt and question" to speedy destruction ; and that the Italians " were pursuing a totally wrong course likely to result in disaster." This may be said to have been preliminary to Sir Edward's now historic attack on the *Inflexible* design.

In spite of the strictures of our ex-Chief Constructor the Italians not only followed up their plan of design undaunted, refusing to put outside armor on the ends of their ships, but actually had the temerity to abandon outside protection altogether—a step which must have fairly taken their critic's breath away. The result is the *Italia* and

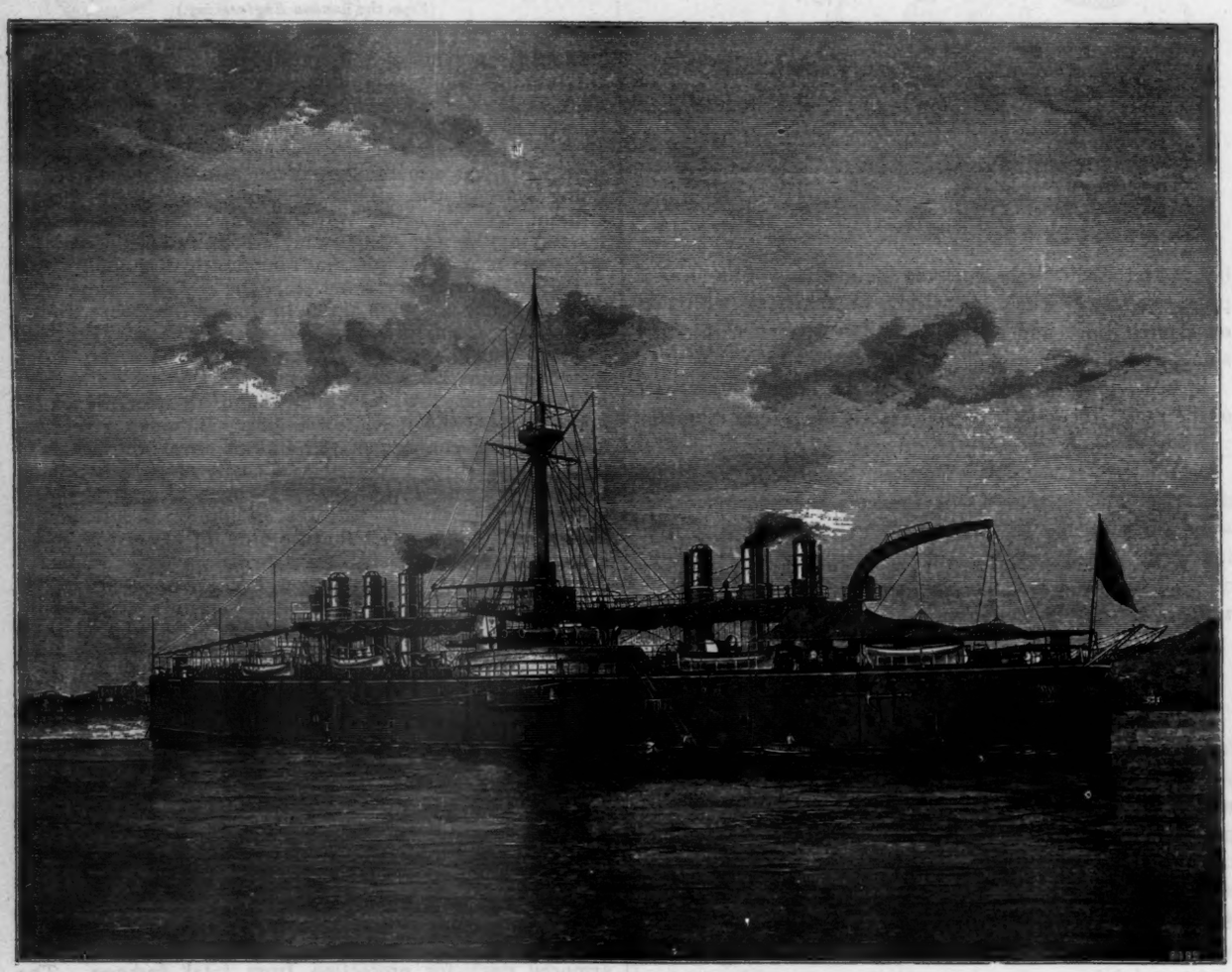
the wonderful ships of the same class which have followed her.

In view of the marvelously rapid progress made in the science of warship construction, the above facts may be looked on by some as quite ancient history, but however that may be, they are pregnant with interest to us at the present day. There are now in progress the two largest and most costly ships that have ever been added to the British Navy. We refer of course to the *Nile* and *Trafalgar*. These vessels are, in the opinion of some of our highest authorities, a distinctly retrograde step; and it is a pretty well acknowledged fact that had the constructive department at Whitehall had their own way, we should now be waiting for the advent of two costly war vessels far more nearly resembling the Italian soft-shelled mammoths than the extensively outside-plated ships in progress, if, indeed, we should not already have been in possession of such engines of warfare.

Had the counsels of Sir Nathaniel Barnaby and those who acted with him been allowed to prevail, there is no doubt but that some of the most important elements of warship design would have been immensely strengthened, and, on the other hand, there is no less doubt that a great sacrifice would have been made to secure these desirable points. Which way the balance of advantages would have turned, it is not our purpose now to consider, although we may perhaps at a future day return to the subject with a view of putting before our readers some of the more salient facts bearing on the question. In the meantime we append the leading features in the design of the *Italia*, which our readers may compare with those of the English ships. It should be remembered, however, that the *Italia* by no means represents the most matured schemes of her talented designer, the *Re Umberto* and the *Sicilia* possessing features that render them an advance upon the first great realization of an internally protected battle-ship.

The following are some of the particulars of design of the *Italia* and the *Lepanto*:

| | Ft. | In. |
|---|---|---|
| Length between perpendiculars | 400 | 6 |
| Breadth of beam at water-line | 73 | 9 |
| " " upper deck | 65 | 6 |
| Draft of water forward | 26 | 6 |
| " " aft | 30 | 6 |
| " " mean | 28 | 0 |
| Area of immersed midship section | 1,770 sq. ft. | |
| Displacement at load draft | 13,480 tons. | |
| Length of armored tower on fore and aft line | 88 | 6 |
| Breadth of armored tower across ship (extreme) | 72 | 6 |



THE ITALIAN WARSHIP "ITALIA."

| | | |
|---|---|---|
| Length of armored tower *per se* | 96 | 0 |
| Breadth " " | 52 | 9 |
| Distance of stem from armored tower | 170 | 0 |
| Thickness of side of tower, including armor | 3 | 3 |
| Thickness of armor on tower | 1 | 9 |
| " " breastwork | 1 | 6 |
| Height of center of heavy guns above water-line | 32 | 8 |
| Height of top of tower above water-line | 30 | 0 |
| " upper deck above water-line forward | 25 | 0 |
| Height of upper deck above water-line aft. | 23 | 0 |
| Height of upper deck above water-line amidships | 22 | 6 |
| Height between upper deck and battery deck | 7 | 9 |
| Height between battery and second deck. | 7 | 9 |
| Height between second and armored deck. | 7 | 6 |
| Depth of lower deck below water-line amidships at sides | 5 | 6 |

| | | |
|---|---|---|
| Depth of hold under lower deck | 21 | 0 |
| Extension of ram beyond forward perpendicular | 6 | 4 |
| Distance of point of ram below water-line. | 8 | 6 |

MACHINERY.

| | | |
|---|---|---|
| Number of engines | 4 sets. | |
| " cylinders | 12 | |
| " propellers | 2 | |
| Diameter of " | 19 | 6 |
| Number of boilers | 26 | |
| " furnaces (three to each boiler) | 78 | |
| Total grate area | 1,521 sq. ft. | |
| Length of ship fore and aft occupied by engines, coal, and boilers | 250 | 0 |

The estimated weights of the hull, armor, etc., were given approximately as follows:

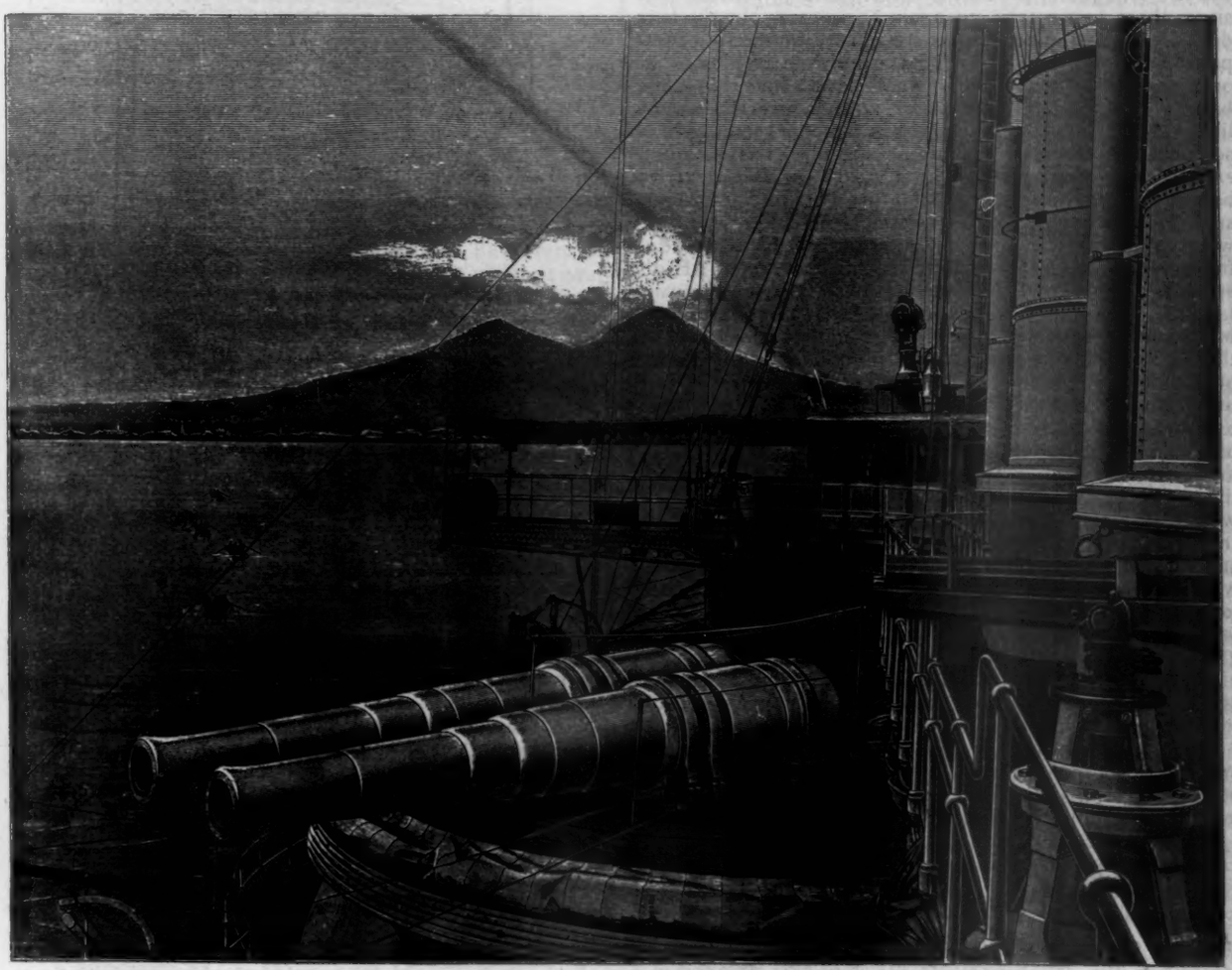
| | Tons. |
|---|---|
| Hull | 5,000 |
| Armor of armored deck | 1,200 |
| " citadel | 900 |
| " ammunition shaft | 246 |
| " chimneys | 552 |
| Total weight of armor | 2,898 |
| Teak backing | 114 |
| The total weight of the machinery is about | 2,200 |

The armament consists of four 43-cm. (100 ton) B. L. R. guns supplied by Armstrongs. There are eight 15-cm. (6-in.) Armstrong breech-loaders. Six of these are carried on the upper deck, two being respectively bow and stern chasers. There are six smaller quick-firing guns of 57 mm. caliber.

There are machine guns comprising 22 Hotchkiss and quick-firing guns for the boats and landing parties. There will also be a number of Maxim guns.

There are four torpedo ports arranged on the broadside, two ahead and two astern.

The two sets of engines for driving each of the *Italia's* twin screws have each three cylinders of equal size arranged in line on the shafting. At full speed they all take steam direct from the boiler, but in ordinary working the foremost cylinder of each set alone takes steam from the boiler, and exhausts into the other two cylinders. There are thus six cylinders to each propeller. The engines are placed amidships, the boilers being placed 14 before and 12 abaft them. The shafting runs under the after boilers. It is this unusual arrangement of the boilers which gives the vessel the somewhat peculiar appearance due to the position of the six chimneys, which it will be seen by the engraving are placed in two groups of three each before and abaft the barbettes. The latter are placed *en échelon*,



THE WARSHIP "ITALIA"—TOP OF CASEMATE.

and each one carries two of the monster 100-ton guns. The barbettes are contained in an armored casemate, which is supported by the unarmored structure of the ship, a point in design that has raised many adverse comments from naval critics in this country. The space thus enclosed is entered from below through an armored shaft, which leads below water to the space between the forward and after sets of engines. This armored tube serves as an ammunition shaft. The bases of the chimneys in each group are also protected by armored belts. The plated deck completes the armored protection of the ship. This deck extends from stem to stern, the armor being of steel, and 3 in. thick. The body plan of the ship shows this deck in a uniform curve extending from side to side. Where it springs from the skin of the vessel it is about 5 ft. 6 in. below water-line, and at its highest part it is about 1 ft. 6 in. below the level of the water. These figures are those which were allowed for in the design, but we believe, as a matter of practice, the *Italia*, like so many other war-

ships, has accumulated weight during construction, so that the deck is more submerged still. It is this under-water arrangement of the armored deck that has been so unfavorably criticised, and it may be noted that in the succeeding ships, *Re Umberto*, *Sicilia*, and *Sardegna*, the crown of the deck has been raised considerably above the water level, so as to conform more nearly to the arrangement followed in our own smaller protected ships of the *Mersey* type.

Steel is largely used in the construction of this vessel, and when we remember that she was commenced 10 years ago, we feel we have another reason to admire the courage and prescience of her designer. The bottom is sheathed with wood. The double bottom has 3 ft. 3 in. between the two skins in the midship part. There are two longitudinal water-tight bulkheads, extending fore and aft for 254 ft. Altogether the hull is divided into 53 vertical divisions, these being split up again horizontally by the four decks. Cork stuffing is extensively used in the side compartments. Six feet above the water-line is a deck of ordinary plating covered with wood; and above this is the battery deck, having a height of 14 ft. above the water-line. Again, 7 ft. 9 in. above this is the upper deck, which supports the casemate containing the big guns mounted *en barbette*. The great height at which the *Italia* carries her guns is a very strong point in favor of her design, such an element being to a warship of the present day, when armored decks form so important an element of defense, very much what length of reach is to a boxer. High speed is another, and perhaps the most important advantage that was aimed at as a counterbalancing advantage in dispensing with side armor. The under-water shape of the *Italia* is very beautiful, and in looking at her model one is forcibly reminded of a remark of our present Director of Naval Construction, Mr. W. H. White, that however unsightly modern warships are to view afloat, some of the most beautiful forms ever produced by the naval architect were hidden from sight below the water-line of the ungainly superstructures. It was hoped that the *Italia* would steam 18 knots, and this was all but got on her trial, the speed, we believe, that was registered being as stated 17.8 knots. The power developed by the engines was considerably short of the contract. It was expected to get 18,000 indicated H.P., but there was a very large falling off from this. There was, it is said, a difficulty in getting air down to the furnaces, and the necessary amount of coal could not be burned. Alterations and improvements are now in course of consideration, and no doubt will lead to an increase in the power developed.

The *Lepanto* has made a satisfactory preliminary trial and has also made a successful run at sea. The full-power trial of this ship has not yet taken place. The *Italia* left Spezia recently to join the Italian fleet at Maddelena.

## FURNACES FOR BURNING LIQUID FUEL.

A SERIES of papers by Herr Busley, of Kiel, a marine engineer, on Furnaces for Burning Liquid Fuel, appeared recently in the *Wochenschrift des Vereines Deutscher*. We present below, in a condensed form, the substance of these articles on a subject which is just now attracting much attention. The accompanying engravings are not intended to be complete drawings, but are simply sketches, indicating to the eye the general form of each device.

Herr Busley divides the plans for using liquid fuel into three classes, as the oil is used in a liquid, a steaming, or a vaporous condition. These classes he describes as: 1. Hearth fires. 2. Gas fires. 3. Spray fires.

As the number of appliances for using petroleum has been very great, the aim has been under each class to refer only to those of a leading or typical character.

### I. HEARTH FIRES.

Under this class are included all those methods in which the design is to place or pour the liquid fuel directly in a fire-box, with an equal distribution, in order to secure complete combustion. This class is subdivided into: 1. Pan fires. 2. Step fires. 3. Drip fires. 4. Oozing fires.

1. *Pan fires* are the simplest and most primitive form of burning liquid fuel. In some of the works in the Baku petroleum district in Russia the waste or residuum from the refineries is put into the fire-box of a boiler in flat bowls. At others it is allowed to run into the fire-box on stones, or on the fire-bars, where it burns as best it may.

Biddle's method, shown in fig. 1, was specially intended for marine boilers, and was tried about 1862. There was a cast-iron fire-box made in one piece and closed at the bottom. The bottom had grooves radiating from the

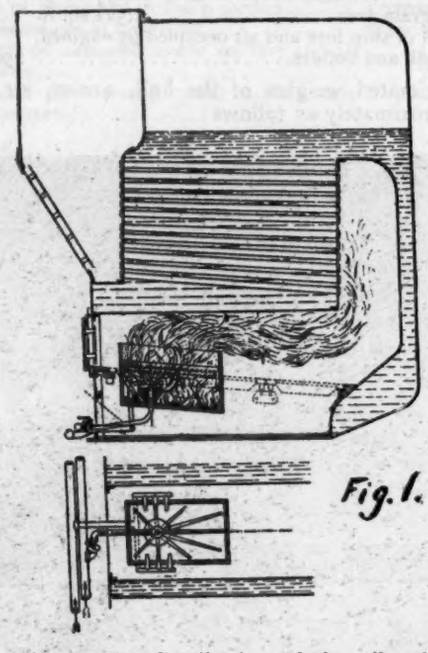


Fig. 1.

center, to insure the distribution of the oil. A storage tank above the boiler holds the oil, and a pipe from this tank carries it down, branch pipes leading to each furnace. These branch pipes are surrounded, at the point where they enter the fire-box, by an iron basket filled with red-hot coal, which sets the oil on fire. Air is admitted through small openings near the top of the furnace, by either natural or forced draft. This apparatus never came into general use.

The trouble with all pan fires has been that it is almost impossible to get a sufficient supply of air, and consequently the combustion is imperfect and is accompanied by a great deal of smoke.

2. *Step fires* are among the oldest devices in use. The most prominent systems are those used by Nobel, and by Ostberg in Sweden, in making his Mitis castings. This system consists of a series of iron troughs arranged in the shape of steps. The oil enters the topmost trough, and then overflows into the others, until it is all burned. Nobel introduced an air current to insure perfect combustion, but Ostberg asserts that this object is attained by a special chimney construction, and that he has succeeded in getting so high a temperature that he can melt iron at a distance of nearly 12 in. from the heating surface. It is further claimed that Ostberg, by the use of this furnace, has made 11 heats or castings in 12 hours.

Step fires are better than pan fires, because air can be admitted from both sides, and because, also, the mass of liquid fuel is much thinner than in pan fires, and better combustion can be attained. For marine engines, however, they are impracticable, as the rolling of a vessel makes the regulation of the quantity of oil that should overflow from one step to the other impossible.

3. *Drip fires* were first tried in 1865, and a system invented by M. Audouin (fig. 2) was shown at the Paris Exposition of 1867. M. Audouin, who was a gas engineer, attached particular importance to the use of the heavy tar oils, and placed a pipe of pottery-ware, from 30 to 40 in. long, in the grate, with a view to keep up a sufficiently high temperature to disperse and consume the oil. In place of a door to the fire-box, a plate was attached, to

which were affixed at the top and in the center rows of small iron pipes. Each pipe had a tap, and could be cut off from the supply pipe leading from the oil tank. To the mouths of the pipes a vertical groove was fitted, down which the ignited oil was conducted. In the case of stationary boilers, Audouin allowed the oil to flow from the supply pipe in a canal along the plate, from which it overflowed into the vertical grooves. This, of course, necessitates only one supply pipe and one regulating tap. The plate that takes the place of the door has openings 0.2 in. wide between the grooves for admission of air. The air supply is regulated by a valve, movable in sections, and fitted in front of the openings. The chimney draft is equal to an air pressure that would raise a column of water 0.39 in., and Audouin claims to have evaporated about 28.6 to 33 lbs. of water with 2.2 lbs. of heavy tar oil in a longitudinal boiler walled in, with internal firing and a wheel draft, which did a duty of about 20 H.P.

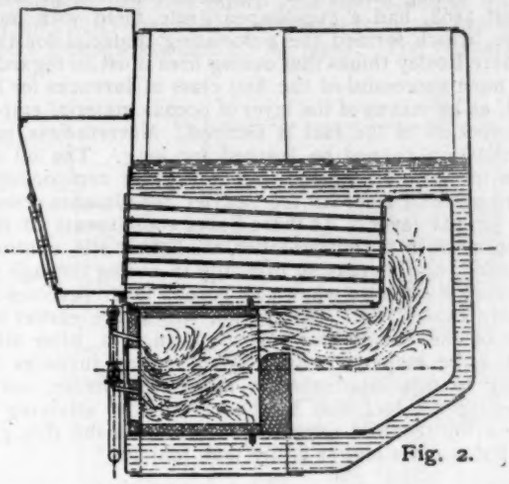


Fig. 2.

Drip fires invented by MM. St. Claire-Deville and Dupuy de Lome, whose plans were based on the system of Audouin, were applied in 1868 to the boilers (fig. 3) of the imperial yacht *Puebla*, the fire-door and fire-bars of which were taken away. A plate of cast iron was fixed on the top, and vertical fire-bricks surrounded by a frame were fitted underneath instead. The upper frame of the plate received the mouths of 13 small pipes, each supplied with a funnel, and into these the oil fell in drops from a supply pipe. This supply pipe had a separate cut-off tap for each small pipe. The oil flowed into the supply pipe from a pipe, also provided with a tap, which was conducted from a tank placed so high as to insure a constant flow of oil. The taps regulated the supply of oil into the different pipes, and consequently its evaporation and distribution. The burning oil flowed out upon the floor of the grate, which inclined slightly backward and was made of fireproof stone, and was roofed over by the same material. The fire-bridge also had a vaulting of the same height. The space between the vaults allowed of the escape of the gases into the tubes. Heavy coal-tar oil, with a specific gravity of 1.044, was the fuel used. At the trial the flame was easily regulated by the taps. Air was admitted by means of valves, as in Audouin's system. A hand fan had to be used to start the fires with, as the low funnel of the yacht did not give sufficient draft; but when the engine was set in motion the exhaust puffed through the funnel, and caused sufficient draft. During the trial trips on the Seine in March and April, 1868, the engines indicated 65 H.P., and consumed 3.24 lbs. of oil per H.P. per hour; whereas they had only indicated 63 H.P. when coal was used, and had consumed 4.96 lbs. of coal per H.P. per hour. Experiments have since been made with this system on the locomotives of the Eastern Railroad of France, in which 1 lb. of oil evaporated 10.9 lbs. of water, while 1 lb. of briquette fuel evaporated 7.9 lbs. water. The inventor claimed that still better results could have been obtained in a specially constructed furnace.

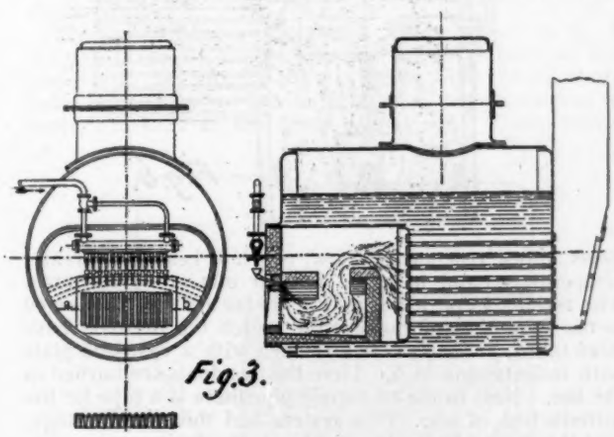


Fig.3.

The drip fires of Wagenknecht (fig. 4), which were made in 1870 and 1871 for Dwrient, at Dantzig, for some torpedo-boats, were chiefly based on Audouin's system. Their principal feature is really the arrangement of the hearth. The oil flowed out of the pipes into the grooves in the fire-bars, of which there were as many as there were pipes; the oil was consumed in these grooves, and air was blown through the spaces from the unused ashpit, as it was found that the natural draft was not sufficient. The petroleum was contained in four tanks fitted behind the engine, which were connected by pipes, and a simple pump worked by the engine. At each revolution of the engine a certain quantity of petroleum was driven into the collecting-pipe in front of the fire-box. But notwithstanding the fans, the combustion was so imperfect that a constant column of thick black smoke came out of the funnel. A particular trouble was the trickling of the oil out of the fire-bars into the engine-room at each roll of the boats. Sometimes the fire went out altogether, owing to stoppage of the supply-pipe or other accidents. These torpedo-boats made about 7.46 knots with petroleum. As this system proved to be inefficient, the boilers were altered and adapted for coal-firing.

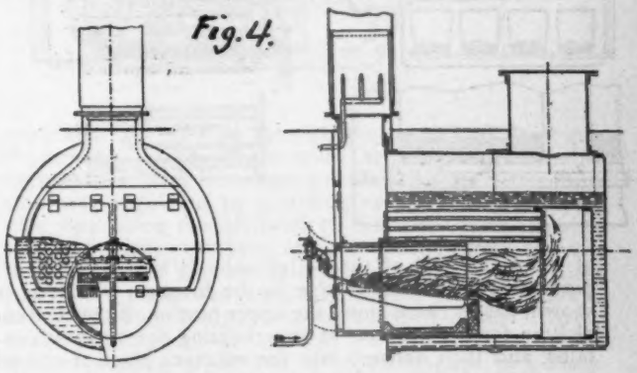


Fig.4.

The drip fire of Kamenski, a variation of the Wagenknecht plan, was used in a stationary boiler at Baku in 1869, and on the steamer *Nasr-Eddin-Shah* in 1872. The results, however, were not satisfactory enough to secure its continued use.

In discussing the value of drip fires the author thinks that the distribution of the burning oil in separate grooves is a great advance on the pan and step systems, as by this method the admission of air is more easy. Nevertheless, the distribution and subdivision of the oil were not carried far enough on this system to insure perfect combustion. The comparatively successful results obtained by Audouin cannot be allowed to carry much weight, as walled-in boilers have such great advantages over marine boilers that the two cannot be compared. Audouin's practice of inserting a pipe of pottery-ware in the furnace was so successful, that it has been largely adopted by modern constructors, especially as by this means coal-using boilers can be easily converted into oil users by removing the fire-bars, which can always be replaced. But the drip fires, although superior to pan and step fires, cannot be regarded as satisfactory. The number of pipes they necessitate

render them too complicated, and make them liable to get stopped up. They are also a source of much annoyance and even danger in rough weather at sea, as the oil is liable to overflow, and they cannot therefore be seriously regarded as practicable.

4. The *Oozing Furnace* of Richardson was patented in England in 1864, and experimented on at Chelsea and Woolwich by the inventor, largely assisted by the Admiralty. After three years a certain measure of success was attained, and illustrations of this method tried in February, 1867, are given in fig. 5. The bottom of the furnace is lined with ordinary burned slack lime which is even at the top, but has vaultings underneath. The oil is conducted into these vaultings from two tanks situated near the boiler; the supply pipe of each furnace has a separate tap

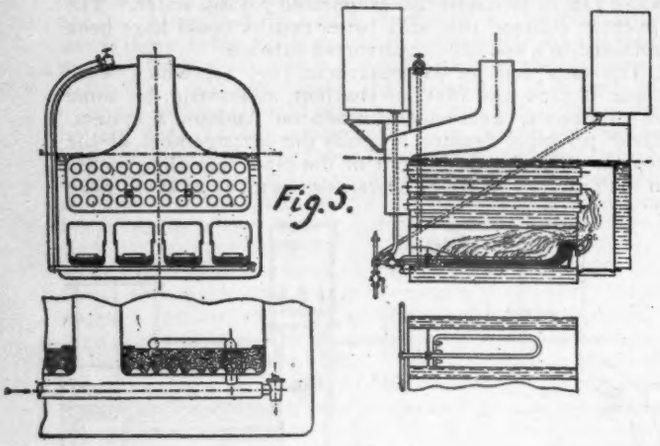


Fig. 5.

at the front wall of the boiler, side by side with the oil pipe; there is a steam pipe in the furnace, which, as is shown, passes twice along the upper portion of the stratum of lime for the purpose of superheating the steam it contains, and then delivers into the entrance place of the oil by means of three conical mouthpieces underneath the stratum of lime. The oil oozes up through the covering of lime, which serves as a sort of wick, and is ignited at once and consumed. The steam is used chiefly for the purpose of getting the necessary draft, but helps also to distribute the oil. Mr. Richardson's last experiments, made in 1867, showed much better results with unmixed than with mixed oils. The highest point attained was the evaporation of 16.76 and 19.66 lbs. of water to 1 lb. of oil. A favorable report was made to the Admiralty, but nothing further was done, chiefly because of the high price of oil in comparison with coal.

The oozing furnace of McKine was patented in the United States in 1865. The floor of the furnace is covered with a layer of sand; the door of the furnace is constructed to admit the air. The sand lies in a closed cast-iron box filled with water. The oil is under this, and traverses this box in a pipe, and enters the layer of sand through which it percolates. The water-box is intended to cool the oil. By means of a tank and pipes this water is removed and replaced by other water when it gets heated. This tank is near the boiler, and its bottom lies rather lower than the sand layer. A pipe leads from this tank into the oil space, and the water can, by turning a tap, be let into the latter, and thus the oil is forced up the pipe that leads it into the sand. It is claimed for this system that the oil used was consumed by a fairly short flame with a natural draft. It never came into extended use.

In Hayes's furnace, also an American invention, oil was allowed to run into the furnace on a layer of coal dust, small stones, etc.

The Patterson oozing furnace was tried in New Jersey about 1878, in a small vertical boiler; it was remarkable from the speed with which steam could be generated from cold water. It consisted of an iron tank, which was filled with asbestos. There were openings at the side of the tank, and the oil was introduced from below through a pipe, which was regulated by a tap. As soon as the asbestos had become saturated with oil it was lighted up, and the flames rose up out of the asbestos and the sides of the tank. Combustion could scarcely have been very perfect, as much black smoke was given off; but later a very high temperature was developed. The use of this system was, apparently, not extended.

The oozing furnace of Verstraet, patented in England about 1868, had a cup-shaped grate, filled with pumice-stone, which formed the percolating material for the oil.

Herr Busley thinks that oozing fires must be regarded as the most successful of the first class of furnaces for liquid fuel, as by means of the layer of porous material employed distribution of the fuel is secured. Nevertheless, perfect combustion cannot be insured for long. The oil is not able to burn off equally, but its lighter components are given off first, whereas the heavier constituents remain in the porous layer. As these heavy constituents of the oil accumulate in the porous layer, the lighter oils, continually supplied, find increasing difficulty in oozing through; and a period must arise when this porous layer becomes completely choked up. This period will arrive earlier in the case of the Richardson furnace, which is, after all, the best, as he employs heavier oils. Oozing furnaces have, owing to this disadvantage, fallen into disuse, notwithstanding the fact that they succeeded in attaining with ease a fourteenfold vaporization, whereas the drip grates did not reach a higher figure than tenfold.

### II. GAS FIRES.

This class of furnaces is that in which the fuel is conducted to the furnace in a gaseous state. The number of devices of this kind is comparatively small.

The gas furnace of Shaw & Linton, which was patented in America as early as 1862, and intended for locomotives and marine engines, represents the transition from hearth furnaces to gas furnaces. As shown in fig. 6, the oil enters a reservoir in a tank in the furnace, and flows on to the fire-plate, which has been previously heated by a coal or wood fire. The lighter oils evaporate and enter the fire-box, where they are consumed. The unconsumed oil

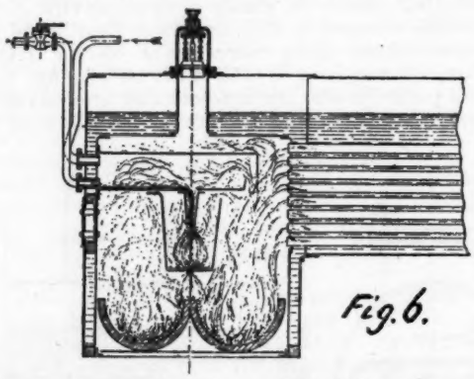
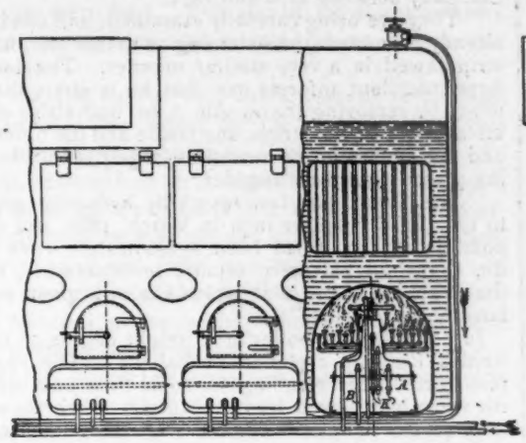


Fig. 6.

flows into a receptacle below, which is heated to greater temperature, and here the heavier oils are evaporated. The residuals that have survived so far are now conducted to the floor of the furnace, from which the fire-bars have been taken, and which is furnished with a cast-iron plate with indentations in it. Here the residuals are burned in the fire. Next to the oil supply pipe there is a pipe for the introduction of air. This system had this disadvantage, that the mass of oil-vapor was not always in consonance with the amount that could be consumed, and consequently, to avoid explosions, a safety-valve had to be provided for the escape of the gases that were in excess. During the trials of Shaw & Linton with a marine engine, the reservoir over the boiler was kept supplied from the tanks by means of a pump, and a steam jet into the furnaces increased the draft. To obtain this steam jet a subsidiary boiler was heated with anthracite before the generation of steam commenced in the main boiler. The trouble with this appears to have been the cost of operating.

The gas furnace of Mallet was patented in France, in 1864, but was intended for laboratories, and not much for boilers. Mallet heated the heavy oils and burned the vapor by means of strong currents of air, which created a very high temperature.

The Foote gas furnace, shown in fig. 7, was tried by the United States Navy Department on the gunboat *Palos* in 1867. This consisted of a cast-iron retort *A*, with a wrought-iron bottom riveted on, which can be fixed to any boiler grate after removal of the fire-bars. The petroleum is introduced into this retort by a pipe *B*, about ⅛ in. in diameter; the vapor of the petroleum then streams out of burners through another set of pipes. The burners are



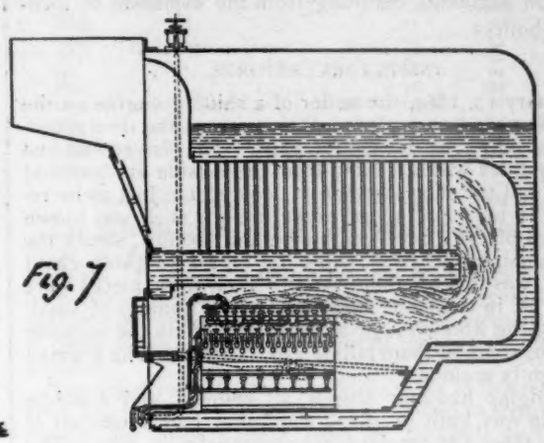


Fig. 7

arranged in rows on the bottom of the furnace. At the top of the retort a pipe containing steam, and another pipe leading from an air-pump, debouch. The pipes marked *K* convey the petroleum vapor to the burners under the retort. A wood fire is kindled on the floor of the retort, until the heat becomes so great that the petroleum entering it is at once volatilized. As soon as the gas begins to burn the wood fire is extinguished. The introduction of steam, air, and oil is regulated by valves in the pipes. In the trial trips it is claimed that in 9 hours 6,000 lbs. of water were evaporated by 279 lbs. of petroleum. The reason that nothing further was done with this system seems to have been that the retort, with the pipes and burners, required constant repairs and would not last, while the pipes were constantly becoming clogged up with the residuals.

The gas furnace of Dorsett & Blythe, shown in fig. 8, differed from that just described in the essential point that the gas to be burned was not made from the oil in the furnace itself, but in two small vertical boilers used as retorts and fired at first with a coal fire. These retorts

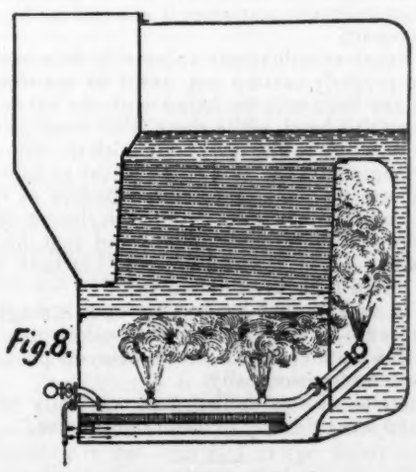


Fig. 8.

are not shown in the sketch. They were filled with a heavy tar oil, of 1.050 specific gravity, and the coal fire started. When the oil vapor reached a pressure of 20 lbs. it was conveyed to the furnaces of the retorts and entered a couple of burners, which continued the evaporation. When the oil vapor reached a pressure of 50 lbs., or a temperature of 500° Cent., it was let into the boiler furnaces. Each of these was closed with an ash-plate, and about 3 in. above this an iron plate was attached, which extended back as far as the combustion chamber. About 3 in. above this sheet again was another iron sheet, shorter and perforated, which was covered with fire-brick. The back opening between these sheets was completely closed with fire-brick, the front only partially so, and thus air could enter and find its way through the perforated sheet into the furnace. Air could also enter the combustion chamber between the lower iron sheet and the ash-plate; its admission was regulated by a sliding valve. The gas supply pipe went along the fire-brick to the combustion chamber and then back, and there was a connection from the rear bend to another pipe in the combustion chamber. These pipes were perforated with holes about 0.07 in. in diameter. The supply of gas was regulated by valves. Owing to the very high temperature of the oil vapor, the retorts and conducting pipes had to be surrounded by a sheet-iron casing filled in with sand. This apparatus was tried on the steamer *Retriever*, of 500 tons. During the trials the engines gave out 150 H.P., the fuel consumption being about 3.53 lbs. of oil per indicated H.P. per hour. The evaporation was at the rate of 12.35 lbs. of water to 1 lb. of oil. The combustion also is said to have been good, no smoke being given out. Somewhat later a furnace on the same plan was tried at Chatham, England, for heating armor-plates; in these experiments about 1 ton of oil was required where 2½ tons of coal were generally used, and the time required for heating the plates was much less. This furnace, however, did not come into use, probably on account of its large first cost and the high cost of the oil compared with coal.

In relation to gas furnaces generally, Herr Busley's opinion is that they give better results than hearth fires. The distribution of the fuel and the subdivision by the use of burners was well carried out in both the plans described above. A sufficient supply of air and good combustion are easily secured. In fact, enough has been done to prove the efficiency of gas furnaces in point of performance. One of the disadvantages which have prevented their adoption is that they are complicated in construction, and consequently their first cost is high. Another disadvantage is that the temperature of oil vapor is about three times as high as that of steam at the same pressure, so that the retorts have to be made enormously strong, and even then are not safe.

But the chief fault of the gas furnaces is the rapid stopping up of the supply pipes, owing to the residuals not vaporizing. This caused suspension of working very rapidly in the case of the Dorsett as well as of the Foote furnace. These disadvantages have outweighed the few advantages gas furnaces possess over hearth fires, and have prevented them from coming into use, without reference at all to the question of the high working expenses during the present comparative state of prices.

(TO BE CONTINUED.)

## LOCOMOTIVE BOILER EXPLOSIONS ON BRITISH RAILROADS.

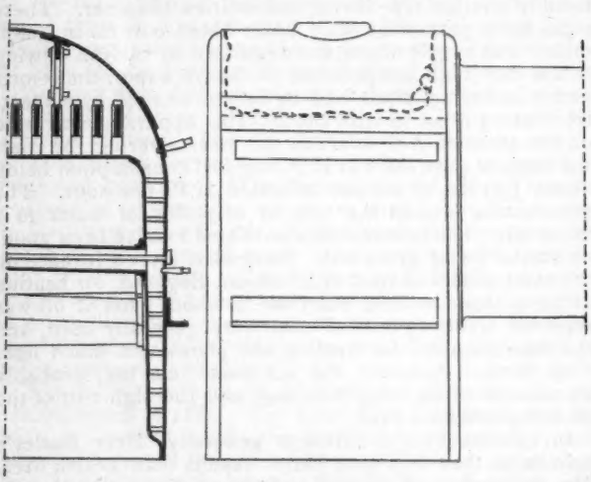
(*Concluded from page 114.*)

WE conclude below the series of condensed statements of the reports of the Inspectors of the British Board of Trade on accidents resulting from the explosion of locomotive boilers.

### INSPECTORS' REPORTS.

February 13, 1884, the boiler of a shifting engine on the Great Western line exploded, the engine at the time standing on a siding in the Exeter yard. The driver had just before noticed water leaking from the outside fire-box, and went to call the shop foreman to look at it. Just as he returned the top-plate of the outer fire-box shell was blown off in two pieces; one, weighing about 600 lbs., struck the engine shed, 200 ft. away, while the other, weighing about 300 lbs., was thrown about 225 ft. Both these pieces were thrown off in the same direction, but a number of small pieces of the wooden lagging were thrown in the opposite direction, some of them falling 450 ft. away. The fireman was slightly scalded.

The engine had four wheels, all coupled, and a saddle tank. It was built in 1873; the boiler had a new set of tubes in 1880, and received general repairs in 1883. The boiler shell was of $\frac{7}{16}$-in. iron and had butt-joints with outside double-riveted strips or cover-plates, 7 in. wide and $\frac{9}{16}$ in. thick, the rivets being spaced 3 in. between centers. The inside fire-box was of copper, and had several cross-tubes connecting the water spaces on each side. The accompanying sketch shows a side view of the rear end of the boiler (the dotted lines showing the lines of



fracture) and a half cross-section of the fire-box, showing the crown-bars, braces, etc. The Inspector's comments on this explosion are as follows:

"It is seldom that so accurate a description of the manner in which a boiler exploded can be given as in this case, where the foreman fitter and the driver actually saw the exact spot where the plate commenced to give way.

"This spot was at the joint of the top-plate and the left-hand side-plate of the fire-box shell, and at a point about 18 in. from the back of the box.

"An examination of the boiler shows that at this point, and more or less all along the joint, there was an old flaw on the inside face of the butt-strip extending at some places through nearly a third of the thickness of the metal, and it is evident that the explosion was due to the weakness of this joint.

"The butt-strip at the corresponding joint on the other side is also flawed in a similar manner, but to a less degree; but the joint on the left side gave way first, the plate being then turned over, ripping up the transverse joints at each side, and breaking across on the right side of the safety-valve seat, along the line of bolts for the sling-stays.

"This form of joint is a bad one, as where there is only one butt-strip an unequal strain is thrown on the two sides of the metal, and any small flaw is very liable to develop to a dangerous extent. The metal of the boiler-plate itself was in good condition.

"There are in all 18 engines belonging to the great Western Railway Company with similar joints, the whole of them having been built for the Bristol & Exeter Railway Company between 1870 and 1875.

"They are being carefully examined, and one of the five already examined (the sister engine to this one) has a butt-strip flawed in a very similar manner. The Locomotive Superintendent informs me that he is strengthening the joints by removing the outside $\frac{9}{16}$-in. butt-strips and fitting instead two $\frac{7}{16}$-in. strips, one inside and the other outside, and that he has in the meantime largely reduced the working pressure on these engines.

"The boiler was last tested by hydraulic pressure up to 170 lbs. per square inch in March, 1880, and it is quite possible that if it had been again tested, when it was in the shops for extensive repairs in September, 1883, that the weakness in the joint which has now given way might have been detected."

July 5, 1884, the boiler of a freight engine on the North British Railway exploded at Balloch. The engine had just started after standing for some time on a siding, and the train had moved less than 600 ft. when the explosion took place. The boiler gave way along the top longitudinal joint of the plate behind the dome, the sheet turning over but not flying off. The explosion was not a violent one, and no damage was done to the engine. A man who was standing on the platform close to the track was fatally scalded, and two employés on the engine were slightly hurt. The engine had 17×24-in. cylinders and six 5-ft. drivers, all coupled. It was built in 1872, and had run in all about 290,000 miles. The boiler was of $\frac{7}{16}$-in. iron, the joints being lap joints. It received a new tube sheet and new set of tubes in 1880, and had been inspected (without removing the tubes) three months before. The usual working pressure was 130 lbs. The Inspector's statement and comments are as follows:

"An examination of the boiler of this engine shows clearly that it gave way along the longitudinal seam or joint at the top of the barrel, and that there was a groove or flaw of long standing throughout the whole length of this joint, which, from its position beneath the over-lap of the plate, could not possibly have been detected by any examination.

"The plate was in many places holding by a mere skin, and it is surprising that it had not given way sooner, but from its appearance I have very little doubt but that the flaw would have been detected if the boiler had been subjected to an hydraulic test when it was last in the shops for thorough repair.

"The usual examinations ordered to be made seem to have been properly carried out, and I do not think, therefore, that any fault is to be found with the servants of the company on this head, while there is no suspicion that the explosion was due to any tampering with the safety-valves, or to any neglect on the part of the driver or fireman.

"I am informed that all the new boilers of this company are now made with a better description of joint—a butt-joint with double cover-strips—and that for the last two years in every case when a boiler has been retubed it has been tested by hydraulic pressure.

"This is as it should be, but I would strongly recommend the company to have all the boilers of old pattern tested in this manner with as little delay as possible; and all boilers tested periodically.

"The metal of this boiler was originally of inferior quality, and has evidently deteriorated by use."

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During the year 1883 only one boiler accident was reported, the collapse of a tube, by which one employé was slightly scalded. This did not require any special examination.

In 1884 there were four boiler accidents reported, in which one man was killed and four employés were injured.

Reports were made in two of these cases only, the others not being of sufficient importance to require investigation.

In 1885 there were no accidents of any kind resulting from the failure of boilers or parts of boilers reported. This was the first year since the reports began in which such a statement could be made.

In 1886 only one boiler accident was reported, in which two employés were hurt. This was of too slight a nature to require investigation, apparently, as no report was made upon it.

During the first half of 1887 there were no boiler accidents reported. The report for the second half of that year has not yet been published.

The first apparent general lesson to be drawn from a study of this series of reports is that, as a rule, boilers explode simply because they are not strong enough to stand the pressure, and not from any mysterious cause. In every case investigation shows either faulty construction, defective material, or weakening from corrosion; or else excessive pressure or low water.

Another fact which the Inspectors have been careful to draw attention to is, that in a great majority of cases the explosions could have been prevented had the boilers been frequently and carefully inspected, and this is, perhaps, the best moral to be drawn.

## Railroad Accidents in Iowa.

THE report of the Iowa Railroad Commissioners for the year ending June 30, 1887, gives the number of accidents to persons on the railroads of that State during the year as follows:

| | Killed. | Injured. | Total. |
|---|---|---|---|
| Passengers | 8 | 28 | 36 |
| Employés | 59 | 354 | 413 |
| Other persons | 65 | 58 | 123 |
| Total | 132 | 440 | 572 |

The number killed is one more than in the previous year; the number injured is five less.

The causes of these accidents are given as follows:

| | Killed. | Injured. | Total. |
|---|---|---|---|
| Train accidents | 10 | 49 | 59 |
| Caught in frogs | 3 | .. | 3 |
| Coupling cars | 9 | 134 | 143 |
| Falling from trains | 23 | 39 | 62 |
| In getting on or off trains | 20 | 47 | 67 |
| Overhead obstructions | .. | 5 | 5 |
| At highway crossings | 4 | 8 | 12 |
| Stealing rides | 9 | 9 | 18 |
| Trespassing on track | 24 | 10 | 34 |
| Intoxicated | 3 | 1 | 4 |
| Suicides | 2 | .. | 2 |
| Miscellaneous | 25 | 138 | 163 |
| Total | 132 | 440 | 572 |

The Commissioners' comments upon the statements given above are as follows:

The three killed by being caught in frogs were one on the Chicago & Northwestern, one on the Sioux City & Pacific, and one on the Burlington, Cedar Rapids & Northern. The Chicago & Northwestern is using a full blocking of wood for its frogs, which is not satisfactory, and proposes to adopt the Edwards' foot-guard. The Commissioners are not informed of the safety appliances against this class of accidents used by the other roads named.

Nine persons were killed and 134 injured coupling cars. The Commissioners in former reports have called the attention of the Legislature to this subject; as yet there has been no action by the State. The Master Car-Builders' Association has agreed upon couplers of the Janney type as in all respects more fully meeting the conditions of the automatic coupler than any other form. Confining the inventive talent of the country to this type of coupler will have the effect to perfect it, and it may not be unwise for the State and General Governments to enact some law requiring the adoption of this type of coupler on all new cars and on the renewal of old cars.

Since the creation of the Board in 1878 the number of persons killed and injured in coupling cars has been:

| | Killed. | Injured. | Total. |
|---|---|---|---|
| 1878 | 17 | 70 | 87 |
| 1879 | 14 | 55 | 69 |
| 1880 | 17 | 87 | 104 |
| 1881 | 20 | 64 | 84 |
| 1882 | 16 | 182 | 198 |
| 1883 | 16 | 98 | 114 |
| 1884 | 8 | 109 | 117 |
| 1885 | 18 | 174 | 192 |
| 1886 | 10 | 126 | 136 |
| 1887 | 9 | 134 | 143 |
| Total, 10 years | 145 | 1,099 | 1,244 |

The persons are nearly all employés whose duty compels them to go where these casualties cannot always be avoided. It is hoped that accidents from this cause may be materially lessened during the coming year, and that the time is not far distant when automatic couplers will be in general use and the recurrence of these accidents mainly avoided.

Twenty-three persons were killed and 39 injured falling from trains. The air-brake when applied to freight trains (which we think cannot long be delayed) will reduce greatly the number of accidents from this cause. We never expect any arrangement can be made to do away with the hand-brake, but cars can be so handled that much of the exposure required on top of trains can be avoided.

Twenty persons were killed and 47 injured getting on and off trains while in motion. As a rule this is the result of individual carelessness, and we can suggest no precaution that will prevent a repetition of these accidents.

Nine persons were killed and 9 injured stealing rides. There is undoubtedly something fascinating in riding on the trucks of a car, for the position certainly is far from comfortable, and the class that travel in that way have no motive generally other than to gratify a taste for vagrancy. The risk is voluntarily assumed, and no one but themselves is responsible for the result.

Twenty-four persons were killed and 10 injured while walking on the track. The reports of this Board, covering a period of 10 years, show that 277 persons have been killed and 178 injured while walking on track; 61 per cent. of these accidents are fatal. We have never believed that the general public appreciated the fact that a railroad track is always and under all circumstances a place of danger and should never be used for foot travel except in crossing. Those persons most familiar with the running of trains are more liable to these accidents than others. We see every year additional reasons why walking on railroad tracks should be made by statute a penal offense, not especially for the benefit of the railroads, but for the safety of the public.

## The New Bombay Water-Works.

(From *Indian Engineering*.)

THE works of the Tansa project for the additional water-supply of the City of Bombay are now in full progress. The lake of supply, situated about 60 miles from Bombay, is to be formed by the construction of a rubble masonry dam across the valley of the Tansa. The length of this dam is 9,000 ft., and its greatest height, across the bed of the river, is 118 ft. This is the height to which it is to be built at present, but the section is so designed that it may hereafter, should additional storage be required, be raised to a height of 135 ft. The total estimated quantity of masonry in the dam, as at present being built, is 10,000,000 cubic feet. The portion across the bed of the river, where the width of the base is 100 ft., has now (January, 1888) been raised to a height of 41 ft. The masonry work is also in progress at different points on the north bank of the river, where the height is comparatively small, being between 40 and 50 ft. The total quantity of masonry executed up to date is 1,300,000 cubic feet. The average

daily number of masons now employed is over 350. The supplying of materials to this number of masons involves arrangements of considerable magnitude, and the total number of hands employed in connection with the dam works average about 4,000 daily. Numerous quarries have been opened in the neighborhood of the dam, and tramways have been laid from them to the site of the works. The lime used is obtained from kunker brought principally from the Nasik districts above the ghâts, a distance of some 40 miles from the works. The sand is obtained from the beds of rivers in the surrounding districts, and it is now brought from an average distance of about 7 miles. As the work progresses this distance will increase, as the sand nearer to hand is used up. For the manufacture of the mortar 8 mortar-pans driven by steam power are in use, besides several edge stone mills, or *ghânis*, which are used for portions of the work detached from the present principal center of operations—namely, the portion of the dam across the bed of the river. The water required for the several operations connected with the work is supplied by two steam pumps (one on either bank of the river) from the lake formed by the water now impounded, and it is distributed all over the works by a system of pipes. The monthly outturn of masonry is now about 300,000 cubic feet. The contractors for this work are Glover & Co. The water is to be brought from Tansa to Ghâtkopar, a distance of 48 miles, by a duct consisting partly of tunnels through the hills, partly of a masonry conduit (cut and cover), and partly of 48-in. cast-iron pipes, or siphons, across the valleys. There are eight tunnels of various lengths aggregating 3 miles, the longest being 6,300 ft. The section of the tunnels is 9 by 6 ft., and the gradient is 6 in. per mile. There are 26 miles of conduits, having a section 7 ft. in width between the walls and 7 ft. in height to the springing of the arch. The gradient is 6 in. per mile. There are seven valleys crossed by 48-in. pipes giving an aggregate length of 19 miles. The hydraulic mean gradient of each line of pipes, or siphon, is 3.2 ft. per mile. Work is in progress at several points along this length of 48 miles and a fair start has been made. Nearly all the tunnel faces have been opened. The shorter tunnels are being driven by hand labor, and in the longer ones the drilling is done by compressed air machinery, the explosive used being dynamite. The excavations for the conduit are in progress, and masonry has been commenced at several points. The earthwork of the siphon tracks on which the 48-in. pipes are to be laid is well advanced, and the laying of the pipes of siphon No. 6, which is 11 miles long, has been commenced. This siphon crosses the Bassein Creek, which separates the island of Salsette from the main land. The place selected for the crossing is at a point where the creek is divided into three channels by islands. The main channel is 1,500 ft. wide, and the two smaller channels each 400 ft. wide. The 48-in. pipes are to be carried over these creeks on bridges of a uniform type.

The superstructure consists of spans 100 ft. long between centers, formed of a pair of lattice girders with cross-girders on which the pipes are laid. The superstructure is supported on abutments and piers, each consisting of a pair of cast-iron cylinders 5 ft. in diameter up to low water spring-tide level, and above that level 4 ft. in diameter. All the cylinders are carried down to rock, and some of them have to be sunk to a depth of 60 ft. under the bed of the creek. Each cylinder is to be filled with concrete, and each pair of cylinders forming an abutment or a pier is to be braced together with heavy wrought-iron bracing. The work of sinking the cylinders is in progress, and a considerable quantity of the material for the bridges is on the ground. The contractors for the whole of the duct works are Walsh, Lovett, Mitchell & Co. The delivery of the 48-in. pipes for the syphons is in full progress, and about 18,000 tons have been delivered. The total quantity of pipes required for the works is some 48,000 tons. The contractors for the pipes are Macfarlane, Strang & Co., of the Lochburn Iron Works, Glasgow.

The water reaches Ghâtkopar at 226 ft. above mean sea-level. From this point into Bombay, a distance of about 12 miles, the water will be brought in pipes, consisting of a 48-in. main for the greater part of the way, and afterward branching into mains of smaller sizes. The line for this portion has not yet been finally located, and the work has not been commenced. All the works have been designed by and are being carried out under the direction of Mr. W. Clerke, Chief Engineer.

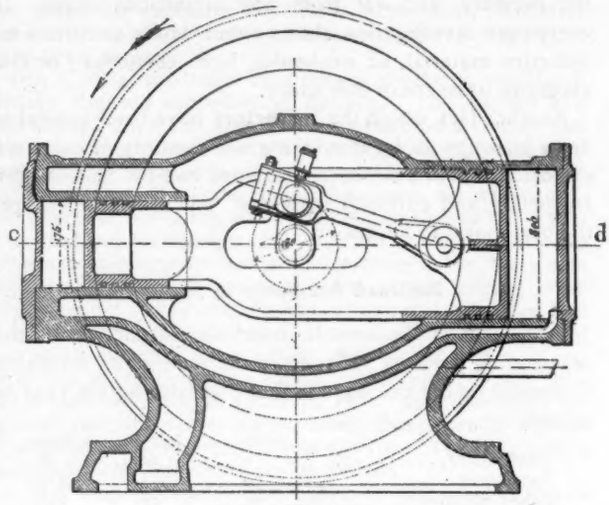
## The Woolf Compound Engine.

(From the *Portefeuille Economique des Machines.*)

THE object which M. Mailliet has proposed in the design of the engine represented in the accompanying cuts is to make a machine, strong, simple, and occupying little room, but nevertheless able to develop considerable power. All the parts are simple and easily accessible.

The engine is formed by two direct-acting cylinders of different diameters, placed opposite each other on the same axis, as shown in figs. 1 and 2. Of these cuts fig. 1 is a section and fig. 2 is a plan with section of the cylinders on the line *c d*, fig. 1.

Fig. 1.



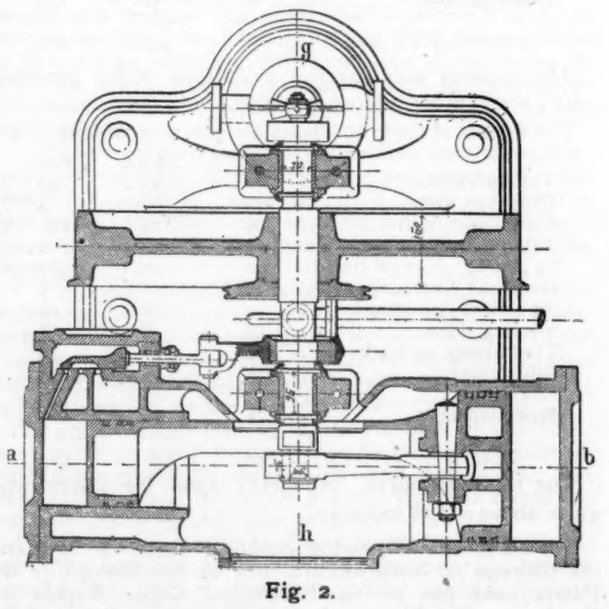




Fig. 2.

The crank-shaft passes between the two cylinders and carries the driving pulley; this shaft can be provided with a second crank to work the condenser pump when it is desired to run the engine as a condensing engine.

The two pistons are formed by a single casting which carries at each end three rings which are pressed against the bore of the cylinder by six or eight little springs placed in grooves. There is no piston-rod, and the connecting-

rod is connected directly to the larger end of the piston, as shown.

The steam admitted in the small cylinder acts upon the piston, then passes into the large cylinder, where it acts upon the larger end of the piston, and completes its expansion.

The distribution of the steam is made in the small cylinder by means of a valve worked by an eccentric keyed

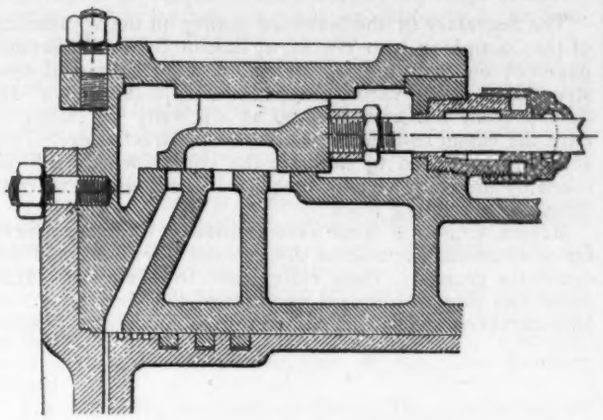


Fig. 3.

on the crank-shaft. Fig. 3 is a section of this valve on a larger scale.

The exhaust-port opens into a passage made in the large casting below the cylinders, through which it passes into the large cylinder. No valve is needed for distribution of steam in the large cylinder.

The machine is provided with a governor on the Damey system with horizontal axis and driven by centrifugal force. This governor is composed of two light, bell-shaped castings of bronze, as shown in fig. 4, which are so adjusted that while one enters the other there is little or no friction. They are joined by two elastic rods, each of which carries, at about the middle of its length, a cylindrical weight. One of the bell-shaped castings is corrugated, its surface forming three grooves of a shape suitable to receive the round belt by which the governor is driven from a pulley on the crank-shaft of the engine. The diameter of these

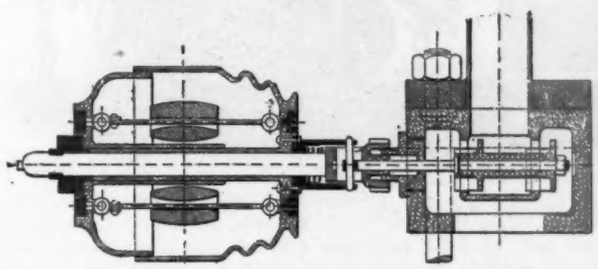


Fig. 4.

grooves is regulated to correspond with the different speeds of the engine. When the speed increases the weight of the elastic rods increases their distances from the center, causing the ends of the rods to approach each other. As one of the bell-shaped castings is fixed the other moves, drawing with it the rod of the steam valve which is attached to it. This valve is a piston valve with two seats so arranged that the least movement acts sensibly on the current of steam.

The use of this governor permits the employment of this engine to run dynamos used for electric lighting.

In actual use this engine is run at a speed of 175 to 200 revolutions a minute. The steam admitted with a pressure of 70 lbs. is expanded 4.3 times in the two cylinders. When the engine is run as a non-condensing engine the power developed is from 6 to 7 H.P.; it has been increased to 10 H.P. when the condenser is used.

This engine occupies a floor-space about 3 ft. 9 in. square, and it is about 3 ft. 4 in. in height.

## The Indian Frontier Railroad.

(From the London *Engineering*.)

As the news from India is that the extension of railways on the northwestern frontier is still being proceeded with, we think it would be of interest to our readers to give them a brief summary of what has been done and of what is now in hand in Beluchistan and its frontier.

The policy of making our frontier unassailable, or at any rate as strong as possible, is one which should meet with the approval of all Englishmen ; and it is a matter of regret that work of this description should have ever become the shuttlecock of party controversy, and that, in consequence, the work should have alternately been pushed on with feverish haste (with the concomitant waste of valuable lives and public treasure), or entirely abandoned, according as each political party was in office. It is to be hoped that the policy now inaugurated of quietly but surely making ourselves secure against invasion, and our frontier easily and quickly accessible from all parts of Hindostan, will be persevered with independently of the fluctuation of Conservative or Liberal majorities in Parliament.

The railway from the Indus near Sukkur toward Kandahar was originally called the Kandahar State Railway, until Mr. Gladstone's Government abandoned the abovenamed place, and it consists of several sections. The first, from Ruk Junction in Scinde to Sibi in Beluchistan, at the foot of the mountains, was laid in 1880, and is a level line across what is known as the " Put."

Sibi is at a level of about 400 ft. above the sea, while the Pishin plateau (on which Quetta is situated) averages 5,300 ft., the edge of the plateau on the Indian side varying in height from 5,800 ft. to 11,000 ft. On the northwest and north this plateau is bounded by mountains separating it from Afghanistan proper ; the northwest range is called the Kwaja Amran, the mountains of which vary from 7,000 ft. to 9,000 ft. in height, while on the north the mountains have no particular name. On the west and southwest the plateau is bounded by an intricate mass of hills and deep ravines quite impracticable for any large body of men ; for besides the geographical difficulties, the water obtainable is rendered unfit for drinking, being impregnated with magnesian and other salts.

From Sibi to the Pishin plateau two caravan routes have existed from time immemorial. One, the Bolan Valley or Pass, the entrance to which is about 20 miles southwest of Sibi ; the other, the Hurnai Pass, the entrance being eight miles north of Sibi. Both these passes are the beds of rivers nearly dry at all ordinary times, but more or less flooded during the winter rains and in the monsoon season. The summit of the Bolan Pass is at a level of 5,800 ft., while that of the Hurnai is 6,600 ft. above sea level.

The Hurnai Pass was selected in 1880, being apparently the easier of the two routes for a railway, although subsequent surveys in 1885 show that this was a mistake, as the Bolan is not only the shorter route, but crosses the summit at a lower level, and would have been cheaper to build. In 1883, when Lord Ripon, then Viceroy, found that it was absolutely necessary to carry on the line toward the frontier, operations which had been abandoned in 1880 were resumed in the Hurnai Valley.

The construction of this second section was placed in the hands of Brigadier-General J. Browne, R.E. Few of the officers, and certainly not their Engineer-in-Chief, had had any previous experience in railway construction, so that it is almost unnecessary to state that the line cost at least 50 per cent. more than it should have done in competent hands. For this waste of public money General Browne and his staff are not so much to blame as the Public Works Minister, who specially selected the Engineer-in-Chief, and allowed him to choose his own staff.

This second section includes a line from Sibi to Quetta *via* Bostan Junction, 20 miles north of Quetta, and a line from Bostan Junction, westward to Killa Abdulla, at the foot of the Kojak Pass over the Kwaja Amran range. The ruling gradient between Sibi and Bostan Junction is 1 in

45, and between the junction and Killa Abdulla 1 in 100. The rails were linked through in this section in March, 1887, but the line is still far from complete.

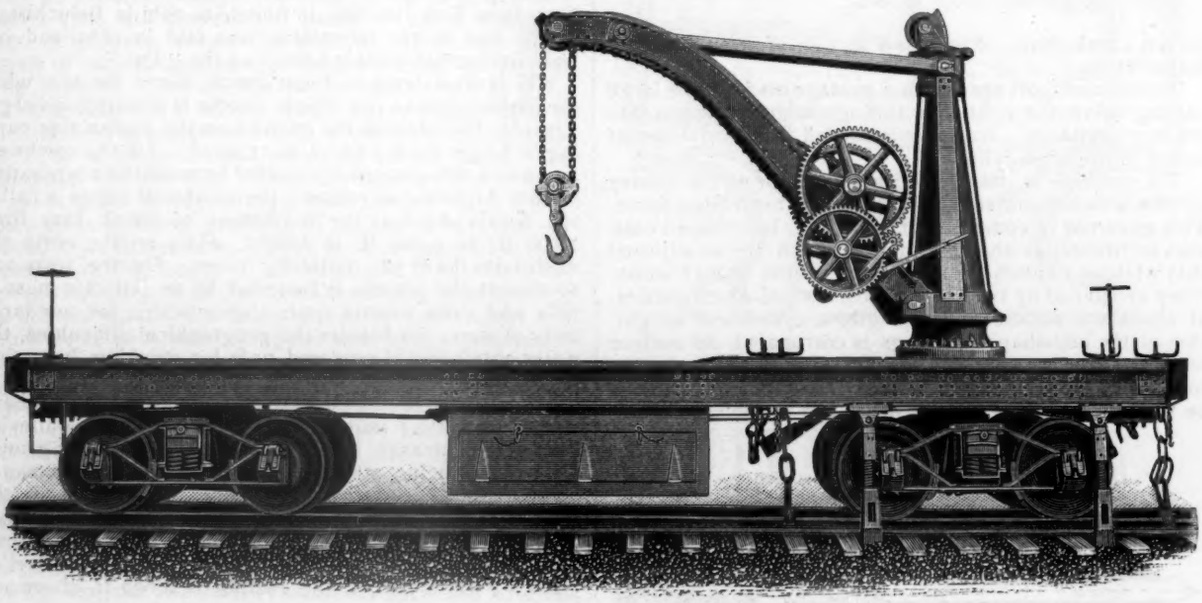
In 1885, after the Penjdeh incident, when war seemed imminent, a temporary line on the 5 ft. 6 in. gauge was laid up the Bolan Pass to within 10 miles of the summit. This third section is laid on the bed of the river, and is liable to disruption by every flood. The remaining 10 miles, owing to the tortuous nature of the pass, were laid on the meter gauge. From the top of the pass to Quetta the line was continued on the broader gauge. This section was completed to Quetta in August, 1886, and the permanent way materials for all the upper portion of the second section as well as for an extension to Kandahar was delivered by it, thus materially expediting the completion of the second, or Hurnai section.

The 10 miles of meter gauge line on the Bolan are now being converted to the 5 ft. 6 in. gauge, with a ruling gradient of 1 in 25, laid with a central rack-rail on the Abt system.

During Lord Dufferin's visit to the frontier in November last, sanction was given to what may be called the fourth section of this railway—viz., from Killa Abdulla on the east side to Chaman on the west side of the Kwaja Amran by the route of the Kojak Pass. The summit of this pass is at a level of 7,200 ft. above the sea, but the railway will pass through at a lower level by a tunnel 2½ miles in length.

The many surveys made during the past three years conclusively prove that this route will be the shortest, quickest, and cheapest to construct. There will be a double line of rails, with a ruling gradient of 1 in 40, and the total length under 30 miles.

The last section, from Chaman to Kandahar, is 80 miles in length, over easy, undulating country, and can be quickly laid should occasion arise. Much has been said about the hostility of the tribes on the frontier, but so far it has been found that Ghilzais and Hazaras are flocking to the works, for they find it more profitable to get regular pay for work done than to pick up a precarious existence by raiding and robbery. Already, on that portion of the line which has been opened, a good traffic has sprung up, and the receipts from this frontier line show that at all events it will pay its working expenses, an event never anticipated when the line was originally projected.



NEW DERRICK CAR, PENNSYLVANIA RAILROAD.

## The Navy and Coast Defenses.

SOME notes in relation to recent progress made in naval matters and to proposed additions to our coast defenses will be found below.

### NAVAL MATTERS.

The Secretary of the Navy, in acting on the application of the Columbian Iron Works, of Baltimore, for the second payment on the gunboat *Petrel*, now in course of construction at their yards, granted the application, but deducted from the amount $500 as a penalty for failing to have the vessel completed within the contract time. This action is supposed to indicate the course which will be taken by the Navy Department in all cases where there is delay in completing work.

Messrs. Cramp & Sons have petitioned the Department for an extension of time on the gunboat *Yorktown* and the dynamite cruiser. They claim that the delay in these cases was due to frequent changes of the steel tests; as manufacturers who furnish material for these vessels would not go on with the work while the Board was considering changes to be made in the tests, fearing that their material would not comply with the amended requirements.

The 6-in. gun cast in Pittsburgh, to which reference was made last month, has been turned and bored without finding any flaws. It has been annealed, and will soon be shipped to Washington, where it will be finished and made ready for trial.

### COAST DEFENSES.

The House Committee on Military Affairs has prepared a bill making appropriations amounting in all to $7,485,000, to be expended on coast defenses. The bill represents not only the views of the Committee, but also those of General S. V. Benet, Chief of Ordnance, with whom the Committee consulted frequently and carefully. The appropriations of the bill in detail are as follows:

Section 1 appropriates $500,000 for submarine mines and appliances for operating them, for continuing torpedo experiments, and for instructing the engineer troops in

details of torpedo service. It is understood that in the expenditure of this money the War Department will act in agreement with the Navy Department, which is now preparing the torpedo boats and appliances for the same service.

Section 2 appropriates $5,000,000 for the purchase of annealed steel for 8, 10, and 12-in. guns, the steel to be of quality and dimensions provided in specifications to be prepared, to be subject to inspection at any stage of manufacture, and to include the parts necessary to make complete guns of each caliber.

Section 3 appropriates $225,000 for the manufacture of breech-loading steel guns, carriages, and equipment for the service of batteries of field artillery. This section will provide for a pressing want, as none of the present field batteries are supplied with guns and carriages of the latest construction.

Section 5 appropriates $500,000 for the necessary expenses of materials and tests required to establish standard types of construction for guns and carriages; also for other necessary expenses of tests.

Section 6 appropriates $760,000 for building tools and fixtures necessary to complete the factory for heavy guns at the Watervliet Arsenal at West Troy, N. Y., in accordance with the recommendations of the Gun Foundry Board.

The remaining sections provide that the guns authorized in this bill shall be manufactured at the Watervliet Arsenal, the material to be procured by contract; and also that the appropriations provided for shall be available until expended.

## Pennsylvania Railroad Derrick Car.

THE accompanying illustration shows a new derrick or wrecking-car recently completed at the Altoona shops of the Pennsylvania Railroad. The car is built almost entirely of iron and is intended to have sufficient capacity for very heavy work in its line. The engraving shows very clearly the general design and plan of construction of the car, in which are included all the improvements suggested by long experience with cars of this class.

## New English Naval Vessels.

(From the London *Engineering*.)

EXAMINING the naval estimates giving the shipbuilding programme for the year we are just entering upon, we find that after finishing the seven armored vessels now in progress, there will remain to complete the armored ships *Victoria*, *Sanspareil*, *Aurora*, *Nile*, and *Trafalgar*. No new armor-clads will be laid down in 1888–89, but the *Superb* and *Thunderer* will be re-engined and the latter will be rearmed. The following is a summary of the new vessels to be put in hand during the year, excluding the ships of the Australasian squadron.

Nine protected ships—viz., two first-class cruisers; one torpedo depot and torpedo carrying ship; two third-class cruisers, steel bottomed, and four sheathed and coppered. There will be fourteen unprotected ships—viz., two sloops of the *Buzzard* type; six gunboats, improved *Rattlers*; six torpedo gunboats, *Sharpshooters*, and a sailing brig for training boys. All are to be built in the dockyards, except a first-class cruiser, a third-class cruiser, and two composite gunboats.

The special squadron for service in Australasian waters will consist of five protected cruisers of new design and two *Sharpshooters*. These seven vessels will be given out to contract.

This Australasian squadron sprang out of the Colonial Conference held in London in 1887, when an agreement was entered into between the Home Government and the Colonial representatives. The mother country is to bear the cost of building, arming, and equipping the ships; while the Colonies will meet the charges of maintenance up to a maximum of £91,000 annually during peace, and in addition pay a sum of £35,000 annually for ten years as a contribution toward the cost of construction. The total cost of these ships will be between £800,000 and £900,000. The ships will be completed in two years. On the expiration of ten years the ships will become the exclusive property of the British Government.

The memorandum next enters into a description of the new designs, from which we extract some particulars.

The cruisers are dealt with first. We are told that the Board well considered all the ships of this class, British and foreign, built and building, and came to the conclusion that two vessels, to be called the *Blake* and *Blenheim*, shall be built of the following dimensions. They will surpass in speed, coal capacity, protection, and armament any ships of the same class yet designed.

| | |
|---|---|
| Length | 375 ft. |
| Breadth | 65 " |
| Displacement (about) | 9,000 tons. |
| Speed on measured mile with full coal supply | 22 knots. |
| Speed at sea, continuous steaming | 20 " |

Radius of action:

| | |
|---|---|
| At 10 knots, about | 15,000 knots. |
| " 20 " " | 3,000 " |

The armament is provisionally as follows:

Two 9.2 in. (22 ton) bow and stern chasers.
Ten 6-in. (5 ton) quick-firers, broadside.
Eighteen 3-pounders, quick-firers.
Four torpedo tubes.

A protective steel deck will run throughout the length of the ship. It will have a maximum thickness of 6 in., which, it is said, will afford the same protection from the "direct blows of projectiles" as would a vertical plate of 12 in. thickness. The phrase is a little obscure. Does it mean "direct" blows on the deck? If so it would be interesting to know how the end is reached. The propelling engines will be of the "vertical triple-expansion" type; and, it is said, many new features will be introduced. Compared to previous cruisers these ships are of large displacement; but if they are contrasted to merchant vessels having speeds of 16 to 20 knots, they are of small size.

We next come to a very interesting vessel, the torpedo depot ship *Vulcan*, which is to replace the *Hecla*. Her principal dimensions will be:

| | |
|---|---|
| Length | 350 ft. |
| Breadth | 58 " |
| Displacement (about) | 6,600 tons. |
| Speed with full coal supply on measured mile | 20 knots. |
| Speed with full coal supply at sea (continuous steaming) | 18 " |

Radius of action:

| | |
|---|---|
| At 12 knots (about) | 12,000 knots. |
| " 18 " " | 3,000 " |

Armament:

Eight 36-pounders, quick-firers.
Twelve 3-pounders "
Four to six torpedo tubes.

A protective steel deck will extend throughout the length of the ship. It will have a maximum thickness of 5 in., and a minimum thickness of 2½ in. Hydraulic power on a large scale will be provided throughout for lifting the boats and doing all kinds of work. The ship will be laid down at Portsmouth. She will be equipped with laboratory, workshop, and a powerful torpedo armament, a large supply of torpedoes, mines, etc. She will be capable of protecting herself against all except the largest classes of cruisers.

The third-class cruisers will be of two types. For distant service where docking accommodation does not exist, four vessels of the *Blanche* class will be wood-sheathed and coppered. Their dimensions are:

| | |
|---|---|
| Length | 220 ft. |
| Breadth | 35 " |
| Displacement | 1,600 tons. |
| Speed with full coal supply on measured mile | 16½ knots. |
| Speed at sea, continuous steaming | 15 " |
| Radius of action at 10 knots | 3 500 " |

Armament:

Six 36-pounders, quick-firers.
Four 3-pounders "
Two torpedo tubes.

A protective steel deck will extend throughout the length of the ship and have over vitals a maximum thickness of 2 in. and a minimum of 1 in. The engines will be of the vertical triple-expansion type with ordinary return tube boilers; twin screws will be adopted.

For service from a base such as the Channel or the Mediterranean, the third-class cruisers will not be sheathed and coppered. They will resemble the *Blanche* in armament and protection, etc., but will have higher speed. A modified locomotive type of boiler, such as fitted in the torpedo gunboats, will be used. A maximum speed of 19½ knots will be reached. The vessels will be 50 ft. longer than the *Blanche* class and of 200 tons greater displacement. Their coal endurance at 10 knots will be about 2,600 knots. . . . .

With regard to the gunboats of the *Magpie* class the memorandum points out that in view of the requirements of the nation, both in peace and war, it has been found necessary to replace the obsolete gunboats and ships now serving abroad. The Board, therefore, determined to build a limited number of gunboats of an exceptionally powerful type in order that they might be able to fulfil the necessary conditions. Nine additional gunboats have therefore been ordered. They are practically identical with the vessels of the *Pheasant* class; but in order to provide for the 4 per cent. "margin for contingencies" ordered by the Board, they have been made 1 ft. broader and about 50 tons greater displacement than the *Pheasant*.

It is estimated that the following is the amount of displacement tonnage which for the three years ending April, 1880, will be passed into the fleet ready for commission: 1887–88, 75,000; 1888–89, 77,000; 1889–90, 75,000. Of this tonnage the following amount belongs to Lord Northbrook's special programme: 1887–88, 21,800; 1888–89, 16,800; 1889–90, 21,500 tons.

## The Engineers' Club.

A MEETING, composed of leading engineers of the various engineering societies residing in New York and vicinity, was held in the rooms of the American Society of Civil Engineers, on the evening of February 3, 1888, Dr. Thomas Egleston presiding.

Upon the unanimous vote of those present, as well as in accordance with the views of many who could not be present, but who sent letters expressive of the same desire, it was decided to organize a social club, with headquarters in New York, for the accommodation of resident and non-resident engineers in the several fields of professional work.

As the first step toward carrying out this decision, the following gentlemen were elected officers to organize the Club and hold office until the first annual meeting: President, James A. Burden; First Vice-President, H. R. Towne; Second Vice-President, J. C. Bayles; Secretary, David Williams; Board of Managers, B. S. Church, Edward Cooper, Thomas Egleston, W. G. Hamilton, J. F. Holloway, W. A. Perry, J. C. Platt, A. C. Rand, R. W. Raymond, F. S. Witherbee.

Mr. Towne, Vice-President, thereupon took the chair, and after full discussion in regard to the details of organization, the following recommendations were made to these officers as expressing the sense of the meeting:

That the name be "The Engineers' Club."

That persons residing in New York City, or within a radius of 150 miles, be received only as resident members.

That persons residing at any distance beyond the above-named limit may be received as non-resident members.

That the initiation fee for the first 250 members, whether resident or non-resident, be $50, and the annual dues for resident members be $35; for non-resident, $20; the year of the Club to begin January 1 and July 1.

That the clauses defining eligibility to membership in the Mining, Civil, and Mechanical Engineers' societies be accepted by the Membership Committee as defining the qualifications for club membership.

The following committees were appointed: On Membership, By-Laws, Incorporation, Library, Location.

As soon as the several committees have completed their work and are ready to report, a general meeting of all whose applications for admission have been favorably acted upon will be called, of which due notice will be given.

From present indications it is deemed probable that the Club will start with a membership of at least 300, and that its numbers will steadily increase in the future.

## CATECHISM OF THE LOCOMOTIVE.

*(Revised and enlarged.)*

By M. N. Forney.

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(*Continued from page* 133.)

### CHAPTER X.

### THE BOILER ATTACHMENTS.

QUESTION 233.—*How is water supplied to the boiler to replace that which is converted into steam?*

*Answer.* It is forced into the boiler against the steam pressure by a force or feed pump, or by an instrument called an *injector*.

QUESTION 234. *How is a feed-pump constructed and what is the principle of its operation?*

*Answer.* The ordinary single-acting pump, fig. 137, used on locomotive and other steam-engines consists of a *pump-barrel*, *A A*, which is a cast-iron or brass cylinder in which a tight-

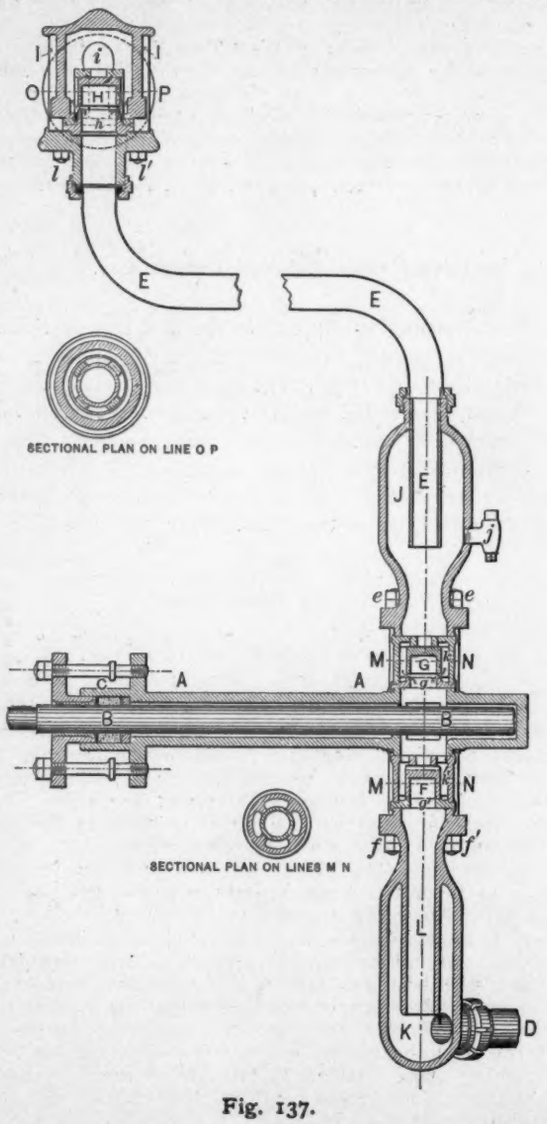



Fig. 137.

fitting piston, *B B*, called the *pump-plunger*, works. This piston or plunger is simply a round rod which works air-tight through a *stuffing-box*, *C*, the construction of which will be explained hereafter. The plunger is usually connected to the cross-head, and receives a reciprocating motion from it, but sometimes the plunger is worked by a small crank attached to one of the crank-pins or by an eccentric on one of the axles. The pump-barrel is connected with the water-tank of the tender by the *suction-pipe* *D* and with the water-space of the boiler by the feed-pipe *E*. Over the suction-pipe *D* is a valve, *F*, called

the *suction-valve*, which opens upward, and below the feed-pipe *E* is another valve, *G*, called the *pressure-valve*. These valves are cylindrical or of the form of an inverted cup. They are made of brass, and rest on brass seats, *g*, *g'*, to which they are fitted so as to be water-tight. They work in guides, *k*, *k*, called *cages*, the form of which is more clearly shown in the sectional plan, fig. 137. When the plunger is drawn out of the pump-cylinder it creates a vacuum behind it, and the pressure above the valve *G* closes it, while the atmospheric pressure on the water in the tank forces it into the suction-pipe *D*, opens the valve *F*, and fills the pump-cylinder. When the plunger is forced back again the force with which it presses against the water in the pump-barrel *A* closes the valve *F*, and lifts the pressure-valve *G*, and the water is then forced through the feed-pipe into the boiler. In order to be certain that the water in the boiler will not flow back into the pump, and also to prevent all the water and steam in the boiler from escaping in case of accident to either the feed-pipe or pump, another valve, *H*, fig. 137, called a *check-valve*, is placed between the feed-pipe and the boiler. The construction of this valve is similar to that of the pressure and suction valves. It is inclosed in a cast-iron or brass case, *I I*. All of these valves have cages or guides in which they work and which also act as stops, to prevent them from rising from their seats further than a certain distance. This distance is called their *lift*, and the successful working of the pumps depends very much on the amount of lift which the valves have. This is usually from $\frac{3}{16}$ to $\frac{1}{2}$ in. The valve *G* is represented open and the darts at *g* show the directions of the flow of the water. The valve *F* is closed.

Over the pressure-valve *G* is a chamber, *J*, called an air-chamber. When water is forced into this chamber, it is obvious that as soon as it rises above the mouth of the pipe *E*, the air above the surface of the water will be confined in this chamber. This confined air, being elastic, will be compressed and expanded by the pressure of the water, so that it forms a sort of cushion, which relieves the pump and the pipes from the sudden shocks to which they are subject, owing to the rapid motion of the pump-plunger.

Another air-chamber, *K*, is sometimes placed below the suction-valve *F*. The object of this is to supply a cushion to relieve the suction-pipe from the shock which is caused by the sudden arrest of the motion of the water in the pipe when the valve *F* is closed. When the pump-plunger is drawn out, the water flows through the valve *F* to fill the vacuum in the pump-barrel *A A*, and consequently all the water in the suction-pipe is put in motion. As soon as the plunger returns, the valve *F* is closed and the motion of the water is suddenly arrested, thus producing more or less of a shock in the pipe *D*. When the water in the air-chamber *K* rises above the mouth of the pipe *L*, it is evident that the air above that line will be confined in the space surrounding the pipe. This air then forms a cushion in the same way as that in the upper air-chamber *J* does, which has already been explained.

QUESTION 235. *How can the pump be taken apart and the valves examined?*

*Answer.* By removing the nuts *e*, *e*, by which the pump-barrel *A A* and the air-chamber *J* are held together, they can be taken apart, and the valve *G* and cage *k* can then be removed. In the same way, by removing the nuts *f f*, the lower chamber *k'* can be detached from *A A*, and the valve *F* and cage *k'* can be taken out. The check-valve *H* can be taken out by removing the nuts *l*, *l'*, which hold up the valve-seat *h* and also the valve and cage.

QUESTION 236. *To what risk is a check-valve like that shown in fig. 137, exposed?*

*Answer.* In case of a collision or other accident it may be broken off, and the hot water then escapes from the boiler, and is liable to scald persons who cannot escape from the wreck. In several instances many persons were scalded to death and others terribly injured in this way.

QUESTION 237. *How can the danger of such accidents be lessened?*

*Answer.* By putting the check-valve inside of the boiler instead of outside. Fig. 138 shows a check-valve of this kind. *A A* is the boiler plate and *B B* is a cast-iron flange cast in one piece with the valve-seat *C*. The flange is bolted or riveted to the outside of the boiler and the seat is let into the inside through an opening cut into the boiler plate. *D* is a flap-valve which covers the opening in the seat. Its position when open is indicated by the dotted lines. *F* is an elbow pipe screwed into the casting *B B*, and is connected with the pump or injector. In case of an accident, if this elbow pipe is broken the valve will still keep its opening closed and prevent the escape of the hot water from the boiler. This or some similar safeguard against the terrible accidents which sometimes result from injury to check-valves should be generally adopted.

QUESTION 238. *How can it be known whether the pump is forcing water into the boiler?*

*Answer.* To show this a cock, called a *pet-cock*, is attached to the upper air-chamber.* By opening this cock, if the pump is working, a strong jet of water will be discharged from it during the backward stroke of the pump-plunger. If the pump is not forcing water into the boiler, or is working imperfectly, the stream discharged from the pet-cock will be weak, and the

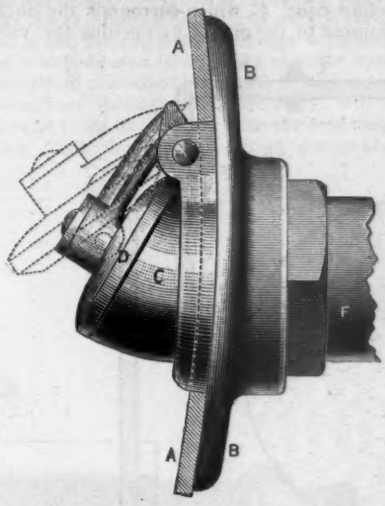



Fig. 138.

backward and forward strokes of the plunger will thus not be very definitely indicated by the discharge from the pet-cock.

Another small cock is often attached to the lower air-chamber, or to the feed-pipe, to allow the water to escape from the pump in cold weather, when the engine is not working, so as to prevent it from freezing.

QUESTION 239. *Why is it necessary to be able to regulate the quantity of water which is forced into the boiler by the pumps?*

*Answer.* Because when the engine is working hard—that is, pulling a heavy load up a grade, more steam and consequently more water are consumed than when it is not working so hard, and therefore more water must be forced in to supply the place of that which is used in the form of steam. If more water is forced in than is consumed, the water will rise and fill the steam-space, and a part of it will then be carried into the cylinders without being evaporated. If too little water is forced into the boiler, the heating surface will not be covered, and there will consequently be danger that those portions which are exposed to the fire will be overheated and injured.

QUESTION 240. *How is the supply of water which is fed into the boiler by the pump regulated?*

*Answer.* By a cock in the suction-pipe called a *feed-cock*, which can be regulated by the locomotive runner, so that more or less water is supplied to the pump. There is also a valve in the water-tank by which the supply of water can be regulated.

QUESTION 241. *On what part of the locomotive are the pumps usually placed?*

*Answer.* They are usually attached to the frames behind the cylinders, and are connected to the cross-head, as has been explained; but they are sometimes placed inside of the frames—that is, between the wheels, and worked from an eccentric on one of the axles, and sometimes they are placed outside of the wheels near the back part of the locomotive, and worked from short cranks attached to the crank-pins.

QUESTION 242. *What provision is made for preventing the water in the pumps from freezing in cold weather?*

*Answer.* Pipes which communicate with the steam-space of the boiler are attached to each of the suction-pipes, so that, by opening valves in the former, steam is admitted into the suction-pipes to heat the water in them.† By admitting this hot water into the pump, it is kept warm, and the water is thus prevented from freezing.

QUESTION 243. *What is an "injector"?*

*Answer.* It is an instrument in which a jet of steam imparts its velocity to water, and thus forces it into the boiler against the pressure of the steam.

QUESTION 244. *What are the principles of the action of an injector?*

*Answer.* The action of an injector is due to the fact that the velocity of steam which escapes from a boiler at a given pressure is very much greater than that of water under the same

* The pet-cock is sometimes attached to the feed-pipe.

† Injectors are now made so that steam can be admitted through them to the heater pipes.

conditions. If water is brought in contact with a jet of steam, the latter will impart its velocity to the water, and by mixing with it the steam will be condensed.

QUESTION 245. *How is an injector constructed?*

*Answer.* Fig. 139 represents an elementary form of an injector. *B* is a boiler and *W* a water-tank. *A* is a pipe to carry steam from the boiler to the injector, and *C* one for supplying it with water, and *D* another pipe to conduct the water to the boiler. The pipe *A* terminates in a nozzle, *F*. The pipe *C* terminates in a hollow cone, *E*, which surrounds the nozzle *F*. When steam is admitted to the pipe *A* by opening the valve *K*,

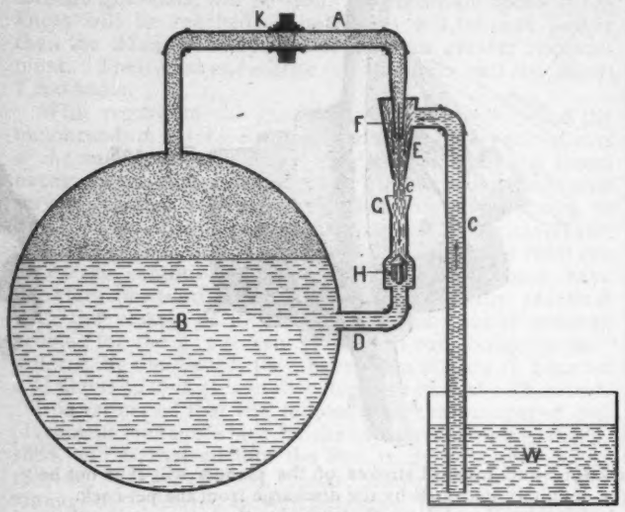



Fig. 139.

it escapes from the nozzle *F* and the lower end of *E*, and creates a partial vacuum in the cone *E* and in *C*. The water is thus sucked up from the tank *W*, and flows through the pipe *C* into *E*, where it meets the current of steam escaping from *F*. This carries part of the water with it, and they escape at *e*. Below *E* there is another tube, *G*, which is connected to the boiler by the pipe *D*, and has a valve, *H*, which is raised up by the pressure of the water in the pipe *D*, and it thus closes the lower end of *G* so that no water can escape from the boiler through the pipe *D*. It will be noticed that there is some space at *e* between the lower end of *E* and the top of *G*. When steam is admitted to *F*, as has been explained, it sucks the water up the pipe *C* and forces it out at *e*. When the stream of steam meets the water in *E* the steam imparts its velocity to the water, but in mixing with it the steam is condensed so that the jet, which escapes from *E*, is composed of water alone. This at first escapes from *e*, but after flowing a few seconds its velocity and momentum become so great that it forces the valve *H* down, and the jet of water then flows into the boiler, against the pressure of the steam. As soon as the injector ceases to work the check-valve *H* is closed by the pressure of the water below it, so that no water can escape from the boiler.

QUESTION 246. *How is the operation of the injector explained?*

*Answer.* The escaping steam from the nozzle *F* unites with the feed-water in the cone *E*, and gives to this water a velocity greater than it would have if escaping directly from the water-space in the boiler. The power of this water to enter the boiler comes from *its weight* moving at the *velocity* acquired from the steam, and it is thus enabled to overcome the boiler pressure.

This can be illustrated with a wooden ball, which will float on the surface of water and will require considerable force to make it sink, but if it is thrown violently into the water, it will sink to a considerable depth before its buoyancy will overcome its momentum, or *actual energy*. If, however, we were to take a cork or very light, hollow wooden or india-rubber ball, no matter how violently we throw it into the water, it will not sink, because the total *actual energy* of any body IS PROPORTIONAL TO ITS WEIGHT MULTIPLIED BY THE SQUARE OF ITS VELOCITY, and therefore if we throw the hollow ball at the same velocity as the solid one, the former will still have much less energy than the latter. Now, as already stated, steam under a given pressure escapes from an orifice with a very much greater velocity than water. But steam being very light, if its weight is multiplied by its velocity its total energy will be comparatively small. Now, in the injector, a portion of the high velocity of steam is imparted to the heavy water, because this water is presented to the action of the steam, not in a mass, as in the boiler, but in small quantity and in such a position that it can easily escape, so that it gradually acquires as high a velocity as the escaping steam can impart, and at the same time the steam is condensed, and therefore there is a heavy substance with a high velocity, whose actual energy is sufficient to overcome the pressure in the boiler. If the steam were not condensed we would have a comparatively light substance moving at a high velocity, which, as has already been explained, would have little actual energy, and would therefore not overcome the boiler pressure.

QUESTION 247. *Will the injector feed hot water?*

*Answer.* The instrument will not work when the feed-water is too hot to condense the steam, for the reasons given above, and the amount of water thrown is always the greatest when the feed-water is the coldest. Steam at a low pressure can be condensed more readily than steam of higher pressure, because it contains less heat. The feed-water may be used hotter to condense low steam than to condense high steam. In using the injector, the lower the boiler pressure the hotter may be the water within certain limits, the limit being the possible condensation of the steam.

QUESTION 248. *How are injectors for use in locomotives constructed?*

*Answer.* The simplest form of injector which is made is that shown in fig. 140, in which all details of construction are omitted. In this the nozzle *E*, called the *receiving-tube*, the cone *E*, called the *combining-tube*, and the pipe *G*, called the *delivery-tube*, are all fixed. In this the steam from the boiler, passing through the pipe *A*, enters the *receiving-tube F*. Here it is joined by the water which enters the pipe *C*. The water condenses the steam in the *combining-tube E*, and a water jet is formed which is driven across the *overflow* space *e e*, and enters the *delivery-tube G*, thence past the *check-valve H* into the boiler. During the passage of the water from *E* to *G*, as it passes across the *overflow* space *e e*, if too much water has been supplied to the steam, some will escape at this point and flow

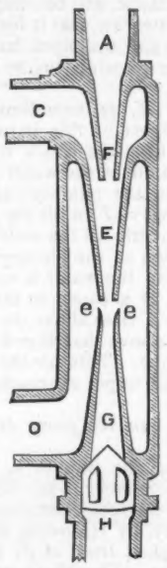



Fig. 140.

out through the *overflow nozzle O*, while if too little water has been supplied, air will be drawn in at *O*, and carried into the boiler with the water.

QUESTION 249. *Will a "fixed-nozzle" injector, such as has been described, answer as a boiler feeder on locomotives?*

*Answer.* It will answer at some one pressure of steam, to which pressure it may have been adapted in making the instrument, and at that pressure it will work admirably; but it will not work satisfactorily at any other pressure, either higher or lower, and has not much range in quantity of water delivered.

QUESTION 250. *What is required to make an injector work at different pressures?*

*Answer.* The instrument must be so made that the water passage between the receiving-tube and the combining-tube can be varied in size. This is usually done by making the combining and receiving tubes conical and moving the former to or from the latter, thus contracting or enlarging the water-space. Such adjustment must be made at each change of steam pressure in the boiler.

QUESTION 251. *Is it essential that injectors should be in a vertical position, as shown in figs.* 139 *and* 140?

*Answer.* No. Injectors will work equally well in any position. For convenience they are usually attached to locomotives, so that their axes or center lines stand horizontal.

QUESTION 252. *What different forms of injectors are used?*

*Answer.* A great variety of these instruments are made, only a few of which will be illustrated and described.

SELLERS' INJECTOR.

Figs. 141 and 142 represent an outside view and section of a self-acting injector manufactured by Messrs. William Sellers & Co. (incorporated), of Philadelphia. It consists of a case, *A*, provided with a steam inlet, *B*, a water inlet, *C*, an outlet, *D*, through which the water is conveyed to the boiler, an overflow opening, *E*, a lever, *F*, by which to admit steam, start and stop its working, a hand wheel, *G*, to regulate the supply of water, and an eccentric lever, *H*, to close the waste-valve when it is desired to make a heater of the injector.

The operation of the injector is as follows: The water inlet *C* being in communication with the water-supply, the valve *a* is opened to allow the water to enter the chamber *I*. Steam is admitted to the chamber *B*, and the lever *F* is operated to lift the valve *b* slightly from its seat. This permits steam to enter the annular lifting steam nozzle *c* through the holes *d d*, while the plug *i* attached to the valve still fills and keeps the tube *K* closed. The steam issuing from the nozzle *c* passes through the annular combining-tube *e* and escapes from the instrument partly through the overflow opening *f* and partly through the overflow openings provided in the combining-tube *g g'*, through the overflow-chamber *J* and passage *E' E*, and produces a strong vacuum in the water-chamber *I*, which lifts the water from the source of supply, and the united jet of steam and water is, by reason of its velocity, discharged into the combining-tube *g*. The spindle *h* is now withdrawn by the lever *F* until the steam plug *i* is out of the forcing nozzle *K*, thus allowing the steam to pass through the forcing nozzle *K* and come in contact with the annular jet of water which is flowing into the combining-tube around the nozzle *K*. This jet of water has already considerable velocity, and the forcing steam jet imparts to it the necessary increase of velocity to enable it to open the valve *K* and thus enter the boiler through the pipe *D*.

If from any cause the jet should be broken—say from a failure in the water-supply—the steam issuing from the forcing nozzle *K* into the combining-tube *g* will escape through the overflows *m* and *n* and intermediate openings with such freedom that the steam which returns through the annular space formed between the nozzle *K* and combining-tube *g* and escapes into the overflow-chamber through the opening *f*, will not have sufficient volume or force to interfere with the free discharge of the steam issuing from the annular lifting steam-nozzle and escaping through the same overflow *f*, and hence the lifting jet will always tend to produce a vacuum in the water-chamber *I*, which will again lift the water when the supply is renewed, and the combined annular jet of steam and water will be forced into the combining-tube *g* against the feeble current of steam returning, when the jet will again be formed and will enter the boiler as before.

If the overflow valve *L* is closed by the lever *H* and steam is then admitted by opening the valve *b*, there will be no outlet for it excepting into the chambers *J* and *I* and if the valve *a* is open into the pipe *C* and thence back to the water-tank. Therefore if it is necessary to turn steam into the supply-pipe or tank to prevent them from freezing, it can be done by closing the valve *L* and opening *a* and *b*.

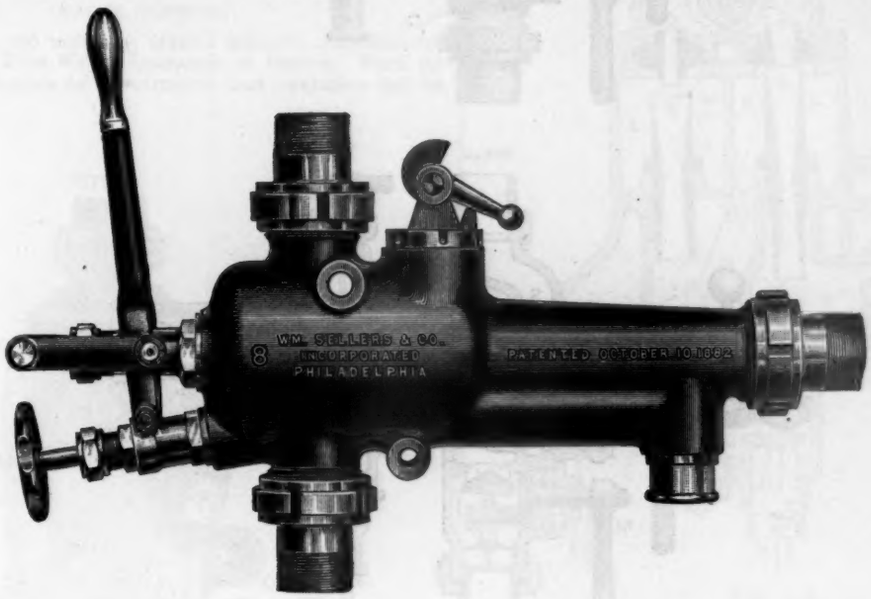



Fig. 141.

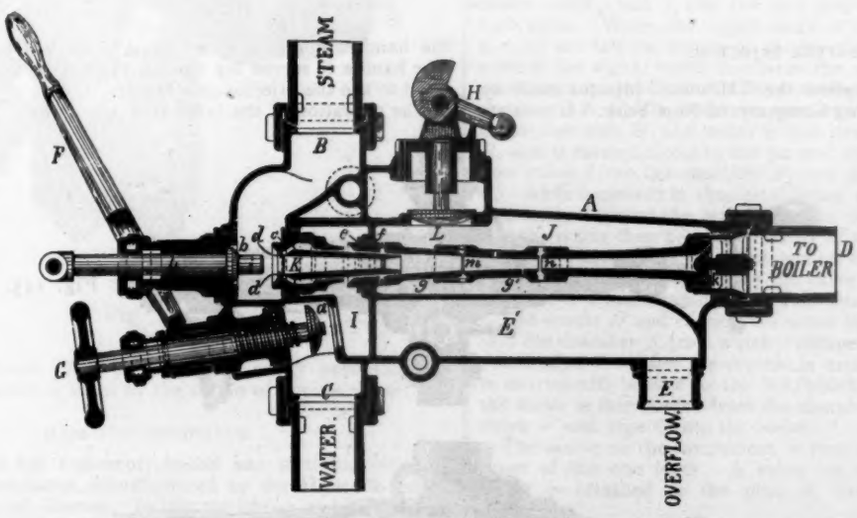



Fig. 142.

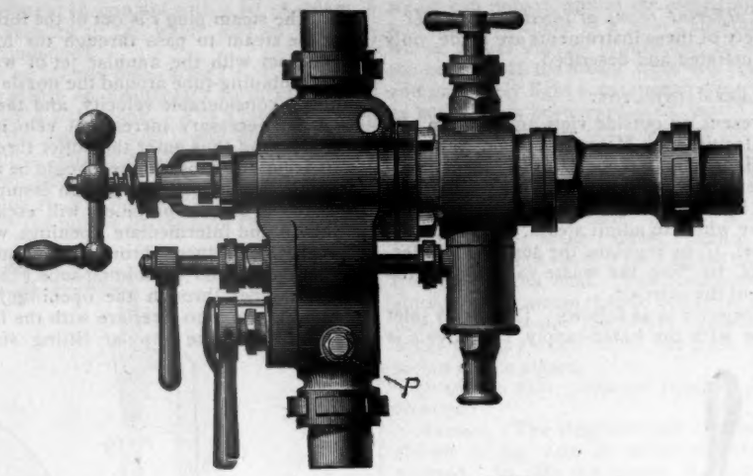


Fig. 143.

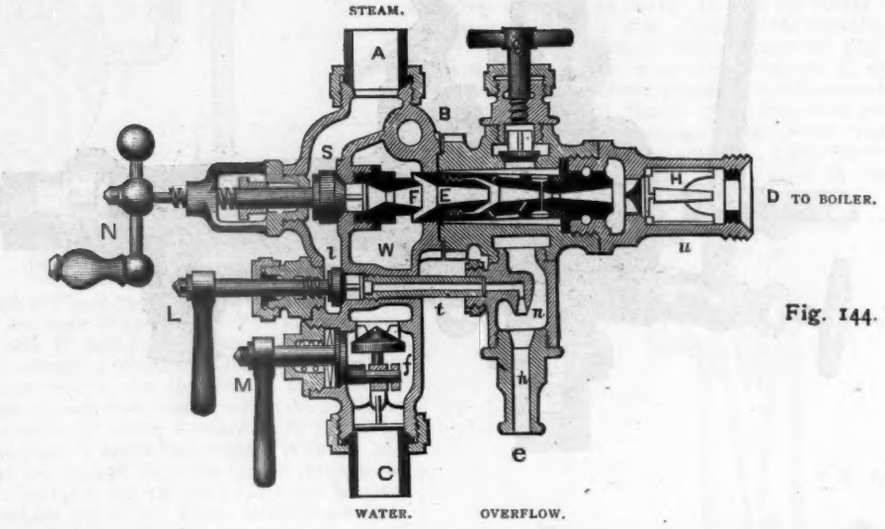



Fig. 144.

MONITOR INJECTOR.

Figs 143 and 144 represent the "Monitor" injector made by the Nathan Manufacturing Company, of New York. It consists of a body, *B*, made in two parts and provided with the usual inlets for steam and water at *A* and *C*, and with a delivery end, *D*. It is further provided with a lifting steam-valve, *l*, which is worked by a handle, *L*; a forcing steam-valve, *S*, worked by the handle *N*, and a water-valve, *f*, worked by a handle, *M*. The handle *O* serves for closing the waste-valve when it is desired to use the injector as a heater.

The operation of the injector is as follows: The water-valve *f* being open and the steam inlet *A* in communication with the boiler, the valve *l* is opened. This operation will admit steam into the tube *t*, which flows through the nozzles *n n'* into the atmosphere, and creates a partial vacuum in the water-chamber

Fig. 145.

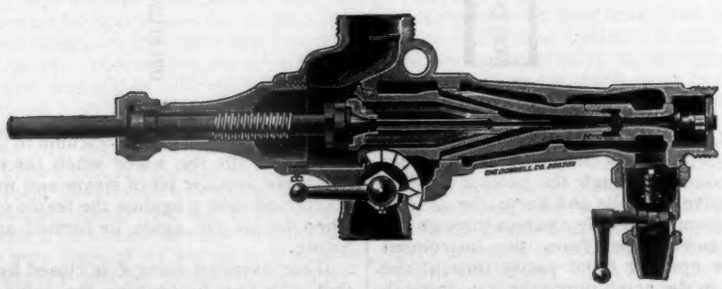


Fig. 146.

*W*. Water is thus drawn from the supply-tank and is discharged into the combining-nozzle *E*, and through openings in this combining-tube into and out through the overflow at *e*. As soon as the water appears at *e* the valve *S* is opened and the valve *l* is closed. The steam issuing from the nozzle *F* meets the water in the nozzle *E*, and imparts to it sufficient force and velocity to open the check-valve *H* and discharge the fluid at *D* into the pipes leading to the boiler. The supply is regulated by the water-valve *f*.

The lifting apparatus in this injector, it will be seen, is separate from and independent of the forcing nozzles, and has a free discharge into the atmosphere. The forcing nozzles are all fixed nozzles, plain in construction, with large and unobstructed water ways. The parts can easily be removed, and as the lifting as well as the forcing nozzles are in straight lines, small obstructions can be removed by passing a wire through them.

### MACK'S INJECTOR.

Figs. 145 and 146 represent Mack's injector, manufactured by the National Tube Works Company, of Boston. From the preceding descriptions its construction and operation will be

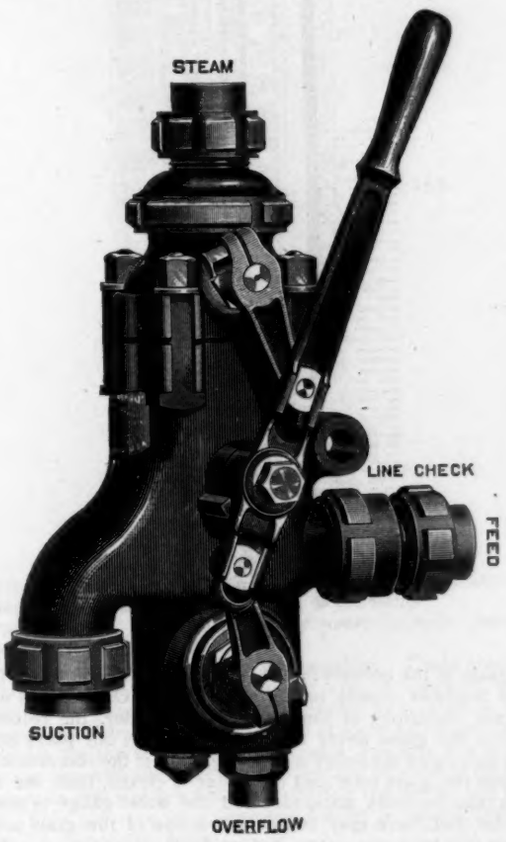



Fig. 147.

readily understood. The parts can be easily removed and cleaned, or renewed if worn by the action of impure water.

### HANCOCK INSPIRATOR.

Figs. 147 and 148 represent outside and sectional views of the Hancock inspirator, manufactured by the Hancock Inspirator Company, of Boston. In this the lifting and forcing jets and nozzles are independent of each other. *A* is the steam-supply pipe, *B* is the water-supply pipe, *C* is the feed-pipe leading to the boiler, and *O* is the overflow. *D* is the lifting jet, *E* the lifting nozzle, *G* the forcing jet, and *H* the forcing nozzle. *F* is a slide-valve which governs the admission of steam to the nozzles. *I* is an overflow valve for the lifting side of the injector, and *J* a similar valve for the forcing side. In fig. 147 a lever and handle is shown by which the working of the instrument is controlled. This lever is represented in two different positions by the dotted center lines *a b c* and *a' b c'*. It is connected to a fixed pivot or fulcrum, *b*, and at its lower end to a short lever, pivoted at *d*, whose center line is represented by the lines *a d* and *a' d*. This lever has a short arm, *e f*, on its lower end connected to the overflow valves *I* and *J*. Above the fulcrum *b* the lever *a b c* is connected to another lever, *g h i*, *g' h i'*, pivoted at *h*.

When steam and water are shut off the long lever and handle stand in the position shown in fig. 147, and indicated by the dotted line *a b c* in fig. 148. The valve *F* then covers both the

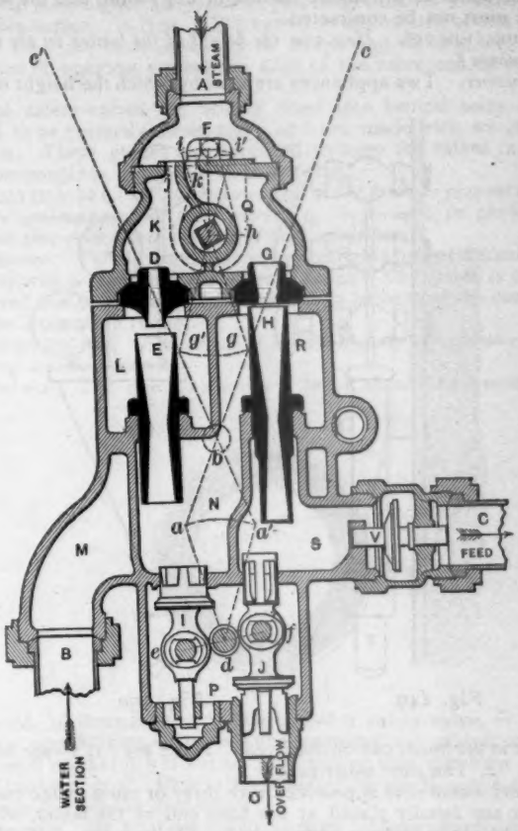



Fig. 148.

steam ports *j* and *k*, and the two overflow valves *I* and *J* are both open. When the upper end *c* of the lever *a b c* is moved toward the left the action of the lever *g h i* moves the valve *F* toward the right, which uncovers the steam-port *j* and admits steam into the chamber *K*; this steam flows through the jet *D* and the nozzle *E*, which produces a partial vacuum in *L*, which communicates with *M*, and water is thus drawn up through the pipe *B*, and is carried along by the jet and escapes through the overflow valve *I* into the chamber *P*, and thence through the valve *O*. After a current is thus established the lever *a b c* is moved still farther toward the left-hand side, which closes the valve *I*, and the water then fills the chamber *N* and rises until it reaches the top of the nozzle *H*. The lever *a b c* is moved still farther toward the left, which moves the valve *F* so as to admit steam to the port *k* and chamber *Q*. This steam flows through the jet *G* and nozzle *H* and carries the water in the chamber *R* with it into the chamber *S*, from which it escapes through overflow valve *J* and pipe *O*. After the current is established the lever *a b c* is moved still farther to the left, which closes the valve *J*, and the water is then forced from the chamber *S* through the check-valve *V* and pipe *C* into the boiler.

The action of the instrument is thus controlled by the movement of the one lever. A valve for regulating the supply of water is attached to the pipe *B*, but is not shown in the engraving.

QUESTION 253. *What attachments are needed in connection with an injector to make it effective?*

*Answer.* A valve should be placed in the pipe by which the injector is supplied with steam. This valve is to be closed only when there is occasion to remove the injector when steam is up, and in cold weather, to prevent the condensation of steam in the pipes at the end of its trips. During the time that the injector is working this valve should be wide open.

QUESTION 254. *In what position are injectors usually placed?*

*Answer.* They are put inside the cab in a position where they can be easily inspected by the locomotive runner.

QUESTION 255. *What is required to keep an injector in good working order?*

*Answer.* Constant use is better than occasional use. When

there are two injectors in an engine, one on each side, the one on the runner's side should be used while running, and the other one when the engine is standing still. All pipe connections must be tight, so as to prevent the leaking of air. The pipe carrying steam to the instrument should be from such part of the boiler as will insure the use of dry steam, and the waste-pipe must not be contracted.

QUESTION 256. *How can the height of the water in the boiler be known?*

*Answer.* Two appliances are used by which the height of the

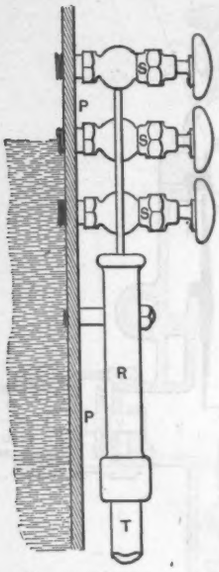



Fig. 149.

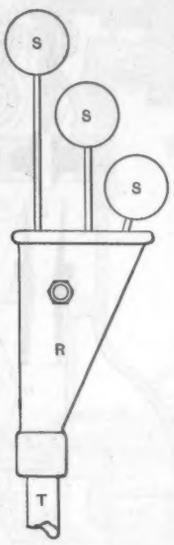



Fig. 150.

water in the boiler can be observed. These are: 1. *Gauge* or *try cocks*. 2. The *glass water gauge*.

Every locomotive is provided with three or more gauge-cocks, which are usually placed at the back end of the boiler, where they can easily be seen and reached. These cocks, *S*, *S*, *S*, *S*, are shown in figs. 149 and 150, which represent the end plate, *P P*, of the boiler in section. They communicate with the inside of the boiler and are so placed that one is three or four inches above the other. The upper cock is placed above the point where the surface of the water should be when the engine is working, and the lower one below it, so that the upper one communicates with the steam-space and the lower one with the water. When these cocks are opened, if the water is at its proper height, steam is discharged from the upper one, and water from the lower one.

When a gauge-cock which communicates with the steam-space is first opened, it is usually filled with condensed water, so that it should generally be kept open for a little while until this water is discharged. If the upper cock is opened and continues to discharge *water*, it indicates that there is *too much* water in the boiler; on the other hand, if steam is discharged when the lower cock is opened, then there is too little water in the boiler, and the heating surface is in danger of being exposed to the fire without being covered with water, and consequently overheated, or, as it is called, "burned," and so injured as to become too weak to bear the strain to which it is subjected by the pressure of the steam. There is then great danger that the crown-sheet may be crushed down by the pressure of the steam above it, or that the boiler may be exploded. Even if no accident occur, the boiler is in great danger of permanent injury from overheating when the water is allowed to get too low.

Below the gauge-cocks, fig. 150, a receptacle, *R*, called *a drip*, is placed to receive the water and steam which are discharged from the cocks. This water is conducted away by the pipe *T*.

The *water-gauge P*, fig. 151, consists of an upright* glass tube, *a a*, which is from $\frac{1}{2}$ to $\frac{3}{4}$ in. in diameter, and from 12 to 15 in. long. The glass is about $\frac{1}{4}$ in. thick. At its ends it communicates with the steam and water of the boiler through brass elbows, *b*, *c*. The openings in these elbows, which communicate with the boiler, are closed by the valves or plugs, *d*, *e*, which are worked by screws and handles, *f*, *g*. The glass tube, when it is attached to the elbows, is made steam-tight by rubber rings, which are pressed tight around the tube by *packing-nuts*, *h*, *i*. The elbows are provided with the valves *d*, *e*, so that in case the glass tube breaks the steam and water can be shut off, so as not to escape through the elbows. The lower elbow is provided with a blow-off cock, *k*, through which any sediment or dirt which collects in the glass tube or elbows can be blown out. When the valves in the upper and lower elbows are opened the steam flows into the glass tube through the upper one, and water through the lower one, and the water assumes a position in the glass tube on a level with the surface of that in

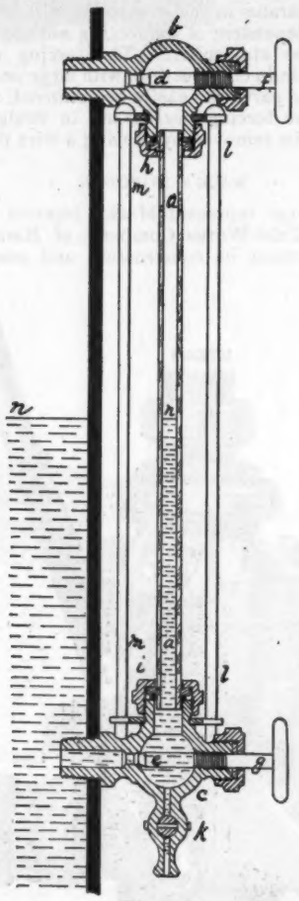



Fig. 151.

the inside of the boiler—that is, the position of the water in the boiler becomes visible in the glass tube. On account of the constant variations of the water in the boiler, the column of water in the glass never remains stationary, but plays up and down as long as the boiler is working. But if the communication between the glass tube and the boiler is closed, then the water in the tube becomes stationary and the water-gauge is useless. In order that there may be no obstruction of the glass tube by mud or dirt from the water, it must be *blown out* often. To do this the lower valve, *e*, is closed, and the blow-off cock *k* and the steam-valve *d* are opened. The steam pressure in the tube on top of the column of water will force it out of the blow-off cock, and the mud and dirt will be carried with it.

If from any cause the glass tube is broken, first of all the water-valve *e* should be closed, and then the steam-valve *d*, so

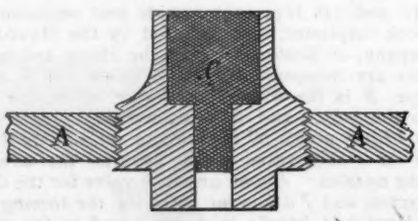



Fig. 152.

as to prevent the hot water and steam which will escape from the broken glass from scalding those who are working the engine. By unscrewing the nuts *h* and *i* the old glass can easily be removed and a new one substituted in its place. Care should be taken in putting in new glasses not to screw the pack-

* Sometimes these tubes are, for convenience, inclined.

ing-nuts down any more than just sufficiently to make the rubber rings steam-tight around the glass tubes. If they are screwed too tight they are apt to produce a strain on the tube, so that the slightest expansion by heat or contraction from cold will break it.

QUESTION 257. *What safeguard is used in locomotives to guard against the danger of low water?*

*Answer.* What are called *safety-plugs* are inserted in the highest part of the crown-sheet. These consist of hollow brass plugs, fig. 152, with a cavity, *C*, in the center, which is filled with metal that melts at a low temperature. The plug is screwed into the crown-sheet *A A*, and its lower end is exposed to the fire. In case the water gets low and the plate is dangerously overheated, the fusible metal melts and runs out of the plug, so

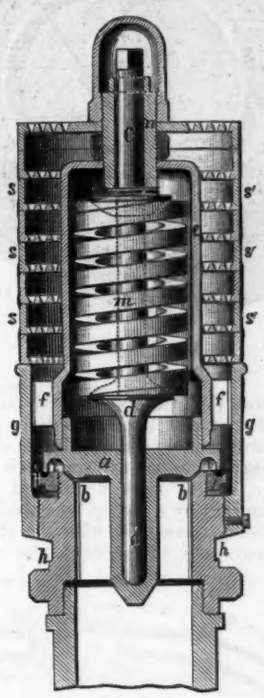



Fig. 153.

that steam can escape through it, which thus gives warning of the danger, and relieves the pressure in the boiler.

QUESTION 258. *How is the steam pressure in boilers prevented from exceeding a certain limit?*

*Answer.* By what are called *safety-valves*. These consist of circular openings, *b b*, fig. 153, about 3 in. in diameter, placed usually on the top of the dome, and covered by a valve, *a*, which is pressed down by a spring, *m*. Two of these valves are usually placed on the top of the dome, so that if one gets out of order the other one will allow the steam to escape as soon as its pressure exceeds that which it has been decided the boiler can safely bear. This pressure in locomotive boilers is usually from 120 to 170 lbs. per square inch.

QUESTION 259. *How is the amount of pressure which must bear on top of a safety-valve determined?*

*Answer.* This pressure is determined BY MULTIPLYING THE AREA OF THE OPENING FOR THE VALVE IN SQUARE INCHES BY THE GREATEST STEAM PRESSURE, IN POUNDS PER SQUARE INCH, WHICH THE BOILER IS INTENDED TO BEAR. Thus, if the opening for a safety-valve is 3 in. in diameter, its area will be 7 square inches, and, therefore, if the greatest steam pressure which it is intended that the boiler shall bear is 150 lbs. per square inch, the valve must be pressed down with a pressure equivalent to $7 \times 150 = 1{,}050$ lbs.

QUESTION 260 *How are safety-valves constructed?*

*Answer.* They are made in a variety of forms. Fig. 153 represents a section of Richardson's safety-valve, which is now in general use. *a* is the valve which rests on the seat *b b*, *c c'* is a spindle, the lower end of which rests on the bottom of the hole in the center of the valve *a*. A spiral spring, *m*, rests on a shoulder, *d*, on the spindle. The pressure on the spring is regulated by the nut *n*, which screws into the case *e*. This case is connected by ribs *f f* to the outer case *g g*, into which the seat *b b* is screwed at *h h*. The valve has a groove, *i i*, around its outside rim. As the valve raises it compresses the spring, which increases its resistance, and therefore without some provision to obviate this difficulty it would be raised only a very short distance above the seat after steam commenced to blow off. For this reason the top, *a*, of the valve is made considerably larger in diameter than the opening at *b b*; in the under side of the valve a groove, *i i*, is turned. When the valve lifts, this groove is filled with steam, which presses against that portion of the valve outside of the opening *b b*, which causes the valve to raise higher and remain open longer than it would without this device. A ring, *j*, is screwed to the outside of the seat *b b*. This can be screwed up or down, and in this way the amount of opening around the edge of the valve can be regulated.

The safety-valves are usually fitted into conical seats, *b b*, so as to be perfectly steam-tight, and are made with wings or guides. These guides are intended to keep the valves in the proper positions in relation to their seats.

QUESTION 261. *What precaution must be taken to prevent reckless or ignorant persons from increasing the pressure in the boiler beyond that which it is thought it will safely bear?*

*Answer.* This is usually done by arranging one of the safety-valves with a lever and the other without. The latter is often covered and sealed or locked up, so as to be beyond the control of the locomotive runner.

QUESTION 262. *How can it be known that the safety-valves are in good working order?*

*Answer.* The one which has a lever should be frequently

Fig. 154.

opened, as there is always danger that a safety-valve, or some of its attachments, may become corroded or otherwise disordered, so that it will not act promptly or with certainty.

QUESTION 263. *How is the noise of the steam which escapes from a safety-valve diminished?*

*Answer.* By what are called *mufflers*. These are constructed in a variety of ways. The principle on which they all act is to subdivide the current of steam, which reduces its noise. Sometimes a vessel is filled with pebbles or glass beads, and the escaping steam is made to pass among them. Fig. 151 shows the arrangement used with Richardson's valve. This consists of a series of perforated plates or discs, *s s'*, *s s'*, which are

Fig. 155.

shown in a plan view in fig. 152. These are placed one on top of the other, and have a space between them. The steam is thus alternately contracted in passing through the holes and expanded in the spaces above them, and in this way escapes through the top plate with very little noise.

QUESTION 264. *How is the steam pressure in the boiler indicated?*

*Answer.* By an instrument called a *steam-gauge*. There are a great variety of such instruments made, but they may all be divided into two classes, and they all operate upon one of two principles. In the one class the pressure of the steam acts upon diaphragms or plates of some kind, as shown in fig. 156, which represents a section of a pair of plates of this kind. *A A* are metal plates made with circular corrugations, as shown in section and also by the shading. The steam enters by the pipe *c* and fills the chamber between the metal plates or diaphragms. The corrugations of the latter give them sufficient elasticity, so

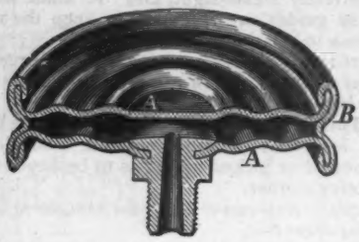


Fig. 156.

that when the pressure is exerted between them they will be pressed apart by the steam. If they were flat, it is plain that they would not yield, or only to a very slight degree, to the pressure of the steam.

Fig. 155 represents a view of a steam-gauge of this kind with its face removed. The diaphragms are shown just below *a*. A bent lever whose fulcrum is at *c* bears on the diaphragm at *a*, and is connected by a short rod, *o d*, to a bent lever, *b*, whose fulcrum is at *e*. This lever has a toothed segment, *f g*, which gears into a pinion on a spindle, *k*. This spindle carries an

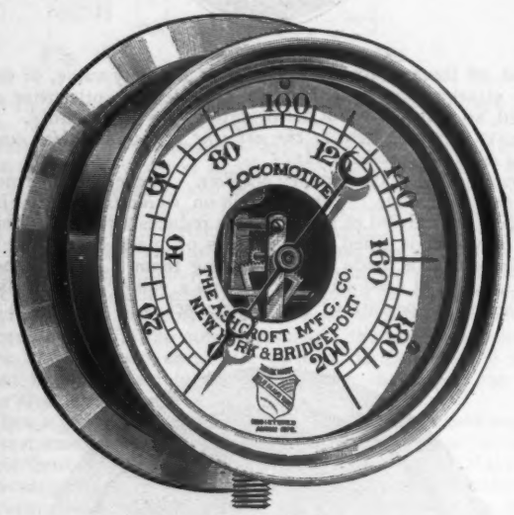


Fig. 157.

index hand or pointer, *h i*. It is plain that any upward movement of the diaphragm below *a* will lift the lever *o a c*, and its motion will be communicated to the lever *b*, and by the segment and pinion to the pointer, and it will indicate the steam pressure on a dial similar to that shown in fig. 157.

QUESTION 265. *What other kind of steam-gauge is used?*

*Answer.* In the other class of gauges, shown in figs. 157 and 158, the steam acts upon a bent metal tube, *a b c*, of a flattened or elliptical section. It may not be known to all readers that if a tube having a section of that form is bent, say in the shape of the letter **U** or **C**, and is subjected to the pressure of a liquid or gas on the inside, the force exerted by the pressure will tend to straighten out the tube. This is due to the effect of pressure on the inside of an elliptical or flat section, which changes its shape and causes it to approximate to a circular form. Thus let *A B*, fig. 159, represent a cross section, and *a b d c* a longitudinal section of a part of such a tube contained between two radii, *o a* and *o b*, drawn from the center *o* of the curve in which the tube is bent. If now we subject the inside of *A B* to a pressure it will have a tendency to assume the form of the circle *C D*, and would then be represented in the longitudinal section by the dotted line *a' b' d' c'*. If we draw radial lines through *a' c'* and *b' d'*, it will be found that they intersect at *o'* instead of *o*, which was the original center of the curve of the tube. It will be seen that as the section of the tube approximates to the form of a circle, the side *a b* which is outside the curve will be moved farther from the center, while the other side, *c d*, is moved nearer to it. As indicated by the radial lines, when this occurs either the outside

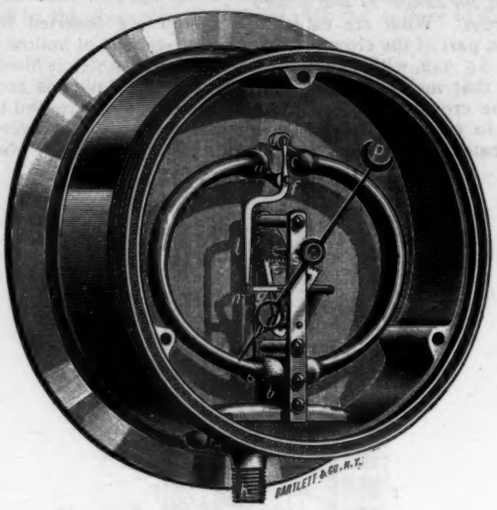


Fig. 158.

must be lengthened and the inside shortened, to conform to the radial lines *a o* and *b o*, or else the tube will be straightened so that the radial lines will assume the position *a' o'* and *b' o'*.

In the gauge represented in fig. 158 (in which the dial-plate is removed), one end, *c*, of the tube is attached to a bent lever, *c f l m*, which is connected by a rod, *g*, to a toothed segment, *e*. The end *a* of the tube is connected with the lever at *f*. It is obvious that as the two ends of the bent tube are forced apart

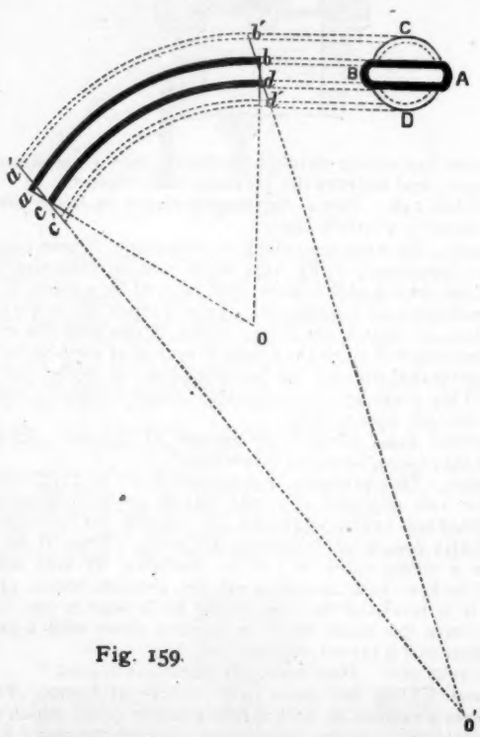


Fig. 159.

by the steam pressure, the lower end of the lever and the segment will be moved toward the left hand side. The segment gears into a pinion on the spindle *s*, which carries the index or pointer, *p p*, which indicates on the dial, fig. 157, the degree of pressure in the tube. The latter is connected with the boiler by a tube attached at *k*. The gauge shown by figs. 157 and 158 is made by the Ashcroft Manufacturing Company, of New York. Various forms of this kind of steam-gauge are made, but all act on essentially the same principle.

The pipe which connects the steam-gauge with the boiler is usually bent to prevent the hot steam from coming in contact with the metal plate or tube, as it is found that the heat of the steam affects their elasticity. When a bent tube is used, the steam from the boiler is condensed and fills the bent portion so that when the steam pressure comes on the surface of the water it forces it up the other leg of the tube into the gauge. A cock is attached to this pipe so that the steam can be shut off in case the gauge should get out of order or require to be removed while there is steam in the boiler.

QUESTION 266. *How can the accuracy of a steam-gauge be tested?*

*Answer.* When the gauge is in good working order, the index or pointer moves easily with every change of pressure in the boiler, and if the steam is shut off from the gauge, the index should always go back to 0. In order to determine the accuracy of its indications, however, they should be tested with a column of mercury. This consists of a long, vertical tube, terminating at its base in a closed vessel filled with mercury. The gauge is then attached to the top of this vessel and water or oil is forced into the vessel on top of the mercury and into the gauge. A pressure of one pound per square inch will force up the column of the mercury 2.04 in., so that by graduating the tube into spaces that distance apart, the divisions will indicate the pressure in pounds per square inch. Thus, a pressure of 50 lbs. would force up the column of mercury 102 in., and with 100 lbs. pressure the column would rise 204 in., and therefore, when

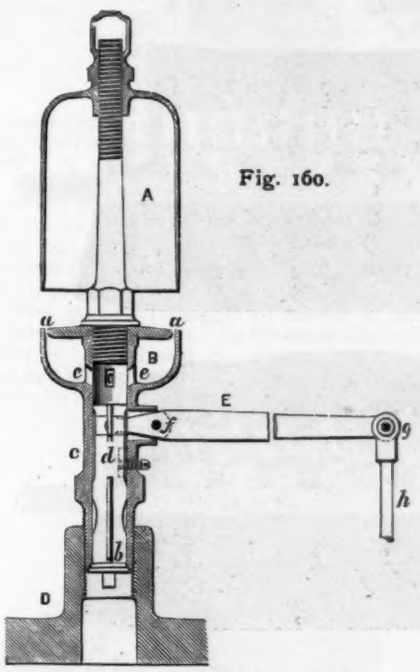



Fig. 160.

the mercury reaches these or any other points, the steam-gauge, if it is accurate, should indicate equivalent pressures.

The ordinary steam-gauges are very liable to get out of order, and therefore they should be frequently tested to ascertain whether their indications are correct.

QUESTION 267. *What is the steam-whistle, and for what purpose is it used?*

*Answer.* The *steam-whistle* shown in section in fig. 158 consists of an inverted metal cup or bell, *A*, made usually of brass. The lower edge of this cup is placed immediately over an annular opening, *a a*, from which the steam escapes and strikes the edge of the cup or bell, which produces a deep or shrill sound, according to the size or proportions of the whistle. The annular opening *a a* is formed by the plate or cover *a a*, which nearly fills the mouth of the cup *B*, which is attached to the stem *c*. The latter is screwed into the top, *D*, of the dome. Communication with the steam-space of the boiler is either opened or closed by a valve, *b*, which is attached to a sort of spindle, *d*, which extends upward inside of the stem *c*. This spindle does not entirely fill the opening in the stem *c*, so that the steam which enters when the valve *b* is opened rises and escapes through the holes *e*, *e*, *e*, into the cup *B* and out through the annular opening *a a*. The valve is opened by the lever *E*, whose fulcrum is at *f*. The end, *g*, of this lever is connected by a rod, *h*, with the cab, and by a suitable handle or lever the valve can be opened and the whistle be blown at any time by the locomotive runner or fireman to give signals to the trainmen, or of the approach of a train to the station, or to warn persons to get off of the track.

QUESTION 268. *How is a locomotive boiler emptied and cleaned?*

*Answer.* One or two large cocks, called *blow-off* cocks, are placed near the bottom of the fire-box, either in front or behind, and sometimes on the side. By opening either of these the water in the boiler is blown out, and much of the loose mud and dirt is carried out with the water.

In order to clean out the mud and scale which are not entirely loose, what are called *mud-plugs* or *hand-holes* are placed in the corners of the fire-box near the bottom. The former are screw-plugs, which can easily be unscrewed. The latter are oval-shaped holes, about 4½ in. long and 2½ in. wide, and covered with two metal plates, one of which is put inside the boiler and the other outside, and fastened with a bolt through both. Another hand-hole is sometimes placed in the bottom of the front tube-sheet. When the boiler is emptied of water the hand-holes are opened by unscrewing the plugs or taking off the covers, and as much dirt is removed as can be scraped out of these holes. A hose-pipe is then inserted and a strong stream of water is forced in, which washes out nearly all the loose dirt, so as to leave the boiler comparatively clean.

When the water is very impure, what is called a *mud-drum* is sometimes used. This is a cylinder of wrought iron attached to the under side of the boiler usually near the smoke-box. It has a cast-iron cover on the bottom which can be removed to clean it. It also has a blow-off cock to discharge the water in it. Much of the mud and dirt is deposited in this receptacle, from which it can easily be removed by taking off the cast-iron cover or blown out through the blow-off cock.

QUESTION 269. *What other attachments are there to the boiler of a locomotive?*

*Answer.* There is a cock, called a *blower-cock*, which is connected to the chimney by a pipe. Steam is conducted through this pipe, and escapes up the chimney in a jet, thus producing a draft when the engine is not working. This arrangement is called a *blower*, and is used to blow the fire when the engine is standing still. The action of the jet is similar to that of the exhaust steam which escapes up the chimney, excepting that the steam from the jet escapes in a continuous stream instead of distinct "puffs," as it does when it is liberated alternately from one end of the cylinders and then from the other.

*E*, fig. 90, is the furnace door, which is fastened by a latch. The latter has a chain attached to it, by which it can be conveniently opened or closed.

QUESTION 270. *How are the grates constructed?*

*Answer.* As has already been explained, they are made usually of cast-iron bars,* *A*, *A*, *A*, figs. 161 and 162, called *grate-bars*. Fig. 161 is a plan, and fig. 162 a horizontal section of one form of grate. The bars in this kind of grate are usually cast in pairs, or sometimes three or more are cast together. They are made wider on the top than on the bottom edges, as shown in the section, fig. 163, so that cinders and ashes will fall through easily, and also to give free access to the air from below. They are usually from ¾ to 1¼ in. wide on the top, and about ¼ in. on the lower edges. The spaces between the bars are made from ¼ to 1¼ in. wide. For burning wood the bars are placed comparatively close together and are stationary, but for burning bituminous coal they are usually made so that they can be moved, in order to shake or stir up the fire, just as is necessary in an ordinary stove or grate fire. In the grate we have illustrated the bars *A*, *A* are cast in pairs, and run crosswise of the fire-box. The ends are made with a sort of journal, *b*, *b*, which rest on two supports, *B*, *B*, called *bearing-bars*, which have suitable indentations to receive the ends of the grate-bars. The latter have arms, *C*, *C*, fig. 162, cast on the under side, to which a bar, *D D*, is attached. By moving this bar back and forth, the grate-bars have a rocking motion imparted to them, as shown in fig. 163. It is evident that in this way the fire over the whole surface of the grates will be disturbed or shaken. The bar *D D* is moved by a suitable lever in the cab. Grates which have movable bars are called *shaking* or *rocking grates*. A great variety of such grates are made and in use, to describe which would require more room than is available here.

For burning anthracite coal what are called *water-grates* are used. These consist of wrought-iron tubes, 2 in. in diameter outside, which are fastened in the front and back plates of the fire-box and are inclined upward from the front end, so that there will be a continued circulation of water through them to keep them cool and thus prevent them from being burned out by the intense heat of the fire.

* In Europe generally, and in some few cases in this country, the grate-bars are made of wrought-iron.

Fig. 161.

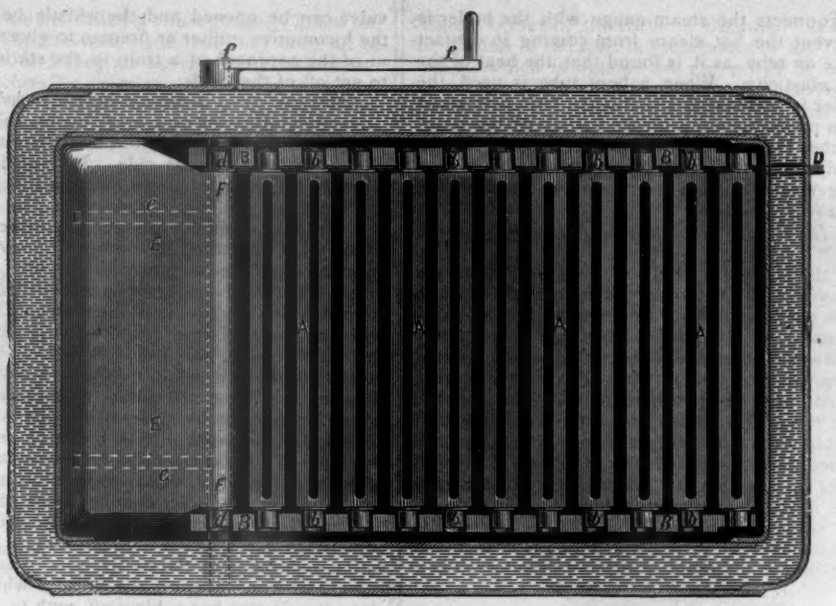


Fig. 162.

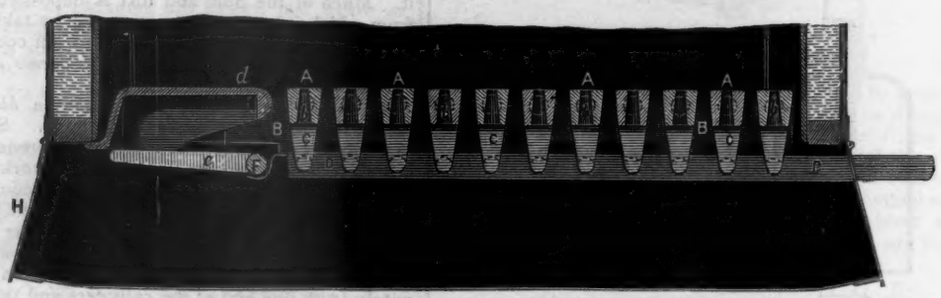
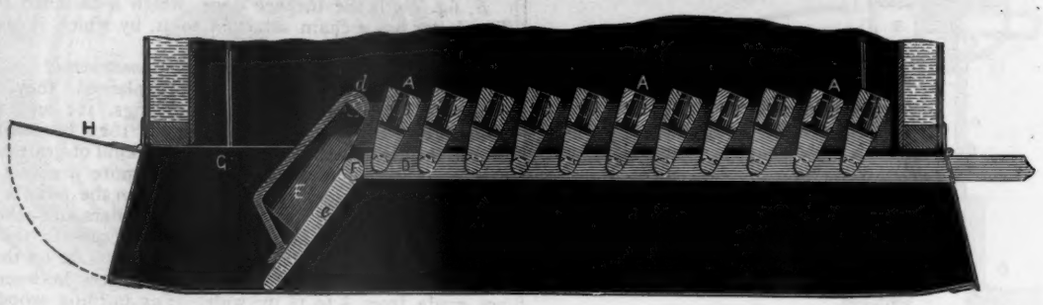


Fig. 163.



The tubes usually have about four solid wrought-iron bars between that number of tubes. These bars can be withdrawn, and the fire then falls into the ash-pan through the opening left by the withdrawal of the tubes.

QUESTION 271. *How is the fire removed from the fire-box when it is necessary to do so?*

*Answer.* In bituminous coal-burning engines, what is called a *drop door*, *E E*, figs. 161, 162, and 163, is provided for that purpose. This door is supported partly on journals, *d*, *d*, similar to those in the grate-bars, on which it can turn, and is held up or prevented from dropping by arms, *e*, *e*, attached to a shaft, *F F*. This shaft is operated by a lever, *f f*, fig. 161, outside the fire-box.

When the arms are in the position represented in fig. 162, the drop-door is held up in the place in which it is shown; but when they are turned as in fig. 163, the door falls down so that the burning coal can be taken out of the opening at *G*, and, by raising up the ash-pan damper, *H*, fig. 163, can be raked out on the track or into suitable pits usually provided for this purpose. The drop-doors are sometimes perforated so as to admit air to the fuel on top of them.

QUESTION 272. *How is the damper of the ash-pan operated?*

*Answer.* It is connected by a rod to a bell-crank, which is moved by the handle, which is raised or lowered, thus opening or closing the damper.

(TO BE CONTINUED.)

# Manufactures.

## Diamonds and Emery Wheels.

AT a meeting of the New York Academy of Sciences, held in April, 1885, Mr. George F. Kunz, the gem expert, exhibited and described a remarkable diamond, which was made up of a multiplicity of twinnings, and was of the character called "extreme durante" by the French. Experiments were soon after conducted by Messrs. Tiffany & Co., who were owners of the diamond, to produce polish sufficient to give the brilliancy necessary in any diamond gem. Its table had been placed on a diamond polishing wheel for 100 days, and the average circumference of that part of the wheel on which it was placed being 2½ ft., the surface that travelled over the diamond table amounted to over 75,000 miles. The diamond fairly plowed the wheel, practically ruining it, so that it required planing before it could be further used.

The stone was kept by Messrs. Tiffany & Co. as a curiosity until November, 1887, when it was bought by the Tanite Company, of Stroudsburg, Pa. The diamond was put to work in the turning room of their establishment, the first solid emery wheel it turned being a coarse, hard wheel 36 in. in diameter and 8 in. thick. In the turning of this wheel the diamond lost

$\frac{1}{32}$ carat in weight. It is a striking fact that a gem of such extreme hardness as is indicated by Messrs. Tiffany & Co.'s experiments should wear so rapidly under the action of a Tanite wheel. As the wheels made by this company are all trued up in a lathe by diamond-pointed tools, the cost of diamonds is quite an item in the expenses.

## A New Oil Burner.

A NEW burner of the spray or jet type for burning oil in boiler furnaces has recently been introduced, which has so far shown very good results. In this burner the scattering or atomizing is effected by passing the oil under pressure through a tube containing a revolving screw. The oil issues in the form of a cone made up of extremely small drops, and meets a current of air, also forced in by a screw. This burner is shown in the accompanying illustrations.

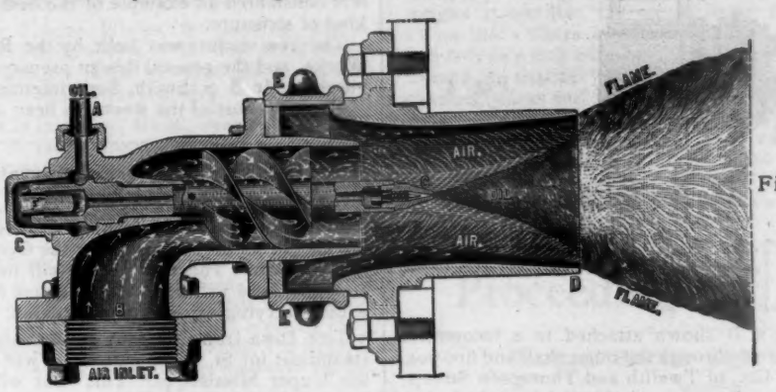



Fig. 1.

Fig. 1 is a section of the burner, in which *A* is the attachment for the oil; *B* the air inlet; *C* the discharge nozzle for the oil; *D* the discharge end of the burner, and *E* a slide controlling an auxiliary inlet through which additional air is drawn by the action of the central discharge. *F* is a strainer fitted in the oil-tube to prevent dirt from passing through. By taking off the cap *G* this strainer can be cleaned out. In the same way the whole tube can readily be removed and the spray-nozzle *C* examined, by unscrewing and taking apart.

The oil must be supplied to the burner under a pressure of not less than 35 lbs. This pressure can be obtained by a closed tank and steam pressure, or in several other methods; usually a small steam pump will be the most convenient.

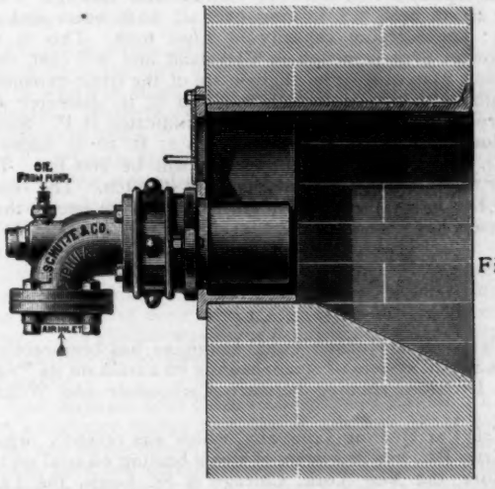



Fig. 2.

The makers give the following hints as to the use of this burner:

"For the purpose of starting the burner before steam is at disposal, the steam-pump can be fitted with a hand-power attachment, but a separate small steam-boiler, or an accumulator, containing a sufficient quantity of oil under pressure, will always be a desirable part of a large oil burner plant.

"The regulation of the burner—viz., the quantity of oil discharge, is had through difference in pressure. Thus, while the pump is set to discharge under a permanent pressure of 150 lbs., the oil inlet to each burner can be so throttled that discharge from burner is under 35 lbs. only, thereby reducing the quantity to less than one-half of what it would be if discharging under 150 lbs. The throttling is done by a small valve in oil branch pipe to each burner.

"The burner can be used with or without blast. Generally, it will not be found necessary, and may even not be desirable to have blast, but where it is required, the pressure need be but low, say from 1 to 3 ounces. A steam jet blower or an ordinary fan blower will furnish blast of suitable pressure, while the connecting pipe should be fitted with a gate for the regulation, if there be an excess of pressure.

"The quantity of the blast is not intended as a supply for combustion. It need be but sufficient for ignition, while a somewhat larger volume is not harmful. . . . .

"The numerous devices in furnace construction, as second combustion chambers, providing for hot air admission, and all improvements leading to perfect combustion or to maintain flame through long passages, apply with advantage to the burning of oil, equally as with coal firing.

"The location of the burner depends entirely on the form of the furnace and the convenience with which it can be attached and operated. It may be fixed horizontal or at an angle with the direction of the flame, upward or horizontal, through the front, through the back, or through the side walls.

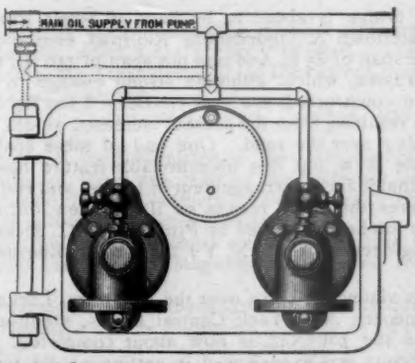



Fig. 3.

"Where the flame has to extend through flues, as under cylinder boilers, in heating furnaces, and under evaporating pans, a favorable direction of the flame is readily arranged. Where, however, the fire-box is short, as is the case in boilers of the locomotive and marine type, or upright tubular, it may be found desirable to direct the flame against a bank of fire-brick, for better distribution. . . . .

"In connection with the attachment of an oil burner to a furnace, particular attention should be paid to the location and volume of air admission. It is well understood that too large an admission, over and above that required for combustion, will cause a lowering of the temperature and a consequent uneconomical result. . . . .

"There is one feature in the burning of oil, as in the burning of natural gas, of which we desire to make mention, the formation of a bank or cake of carbon at a point generally slightly in front of the flame. The amount of this carbon varies with different oils, as also with the arrangement of the furnace. Strange to say, this carbon does not burn in the oil furnace, while when taken out it is the very best fuel.

"The reason for its formation is given in the fact that if unignited parts of oil strike hot fire-brick or other surface of certain temperature, carbon is deposited, while the remainder forms into a gas, which is burned. In long furnaces the formations will be less than in short ones, and while there is little or none with light oils, there will be more when burning heavier oils."

The remaining illustrations show several methods of attach-

ing this burner to boiler furnaces. Fig. 2 shows the burner fixed through the brick wall of a furnace; in this case a square-cornered iron frame is used with a plate in front having two holes, one to receive the burner, the other closed by a door, for the purpose of introducing the lighting torch and observing the flame.

In fig. 3 two burners are shown fixed through the fire-door opening on a plate, which is carried by the hinges provided for

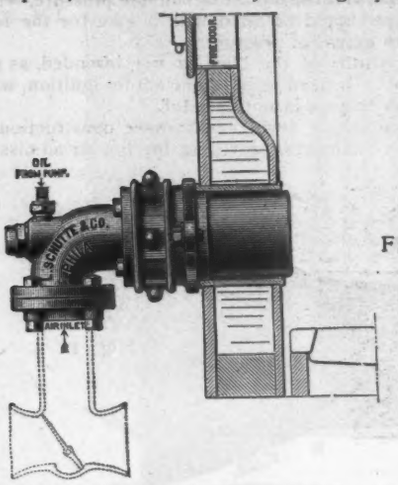



Fig. 4.

the fire-door. In fig. 4 it is shown attached to a locomotive boiler, a tube being inserted through the outer shell and fire-box.

Messrs. L. Schutte & Co., of Twelfth and Thompson Streets, Philadelphia, are the manufacturers of this device, which they have named the "Cyclone" burner.

## New Bridge Structures.

A NEW bridge is about to be built at Sugar River on the Rome, Watertown & Ogdensburg Railroad, consisting of one iron lattice span of 85 ft. and one pin span of 150 ft., to replace Whipple trusses, which, although strong enough to carry the traffic when constructed, are now considered too light to resist the strains resulting from the present increased weight of rolling stock passing over the road. One end of these spans is on a considerable skew, but this objectionable feature has been entirely eliminated by an arrangement of trusses and end stringers which secures the same results as if the skew did not exist. The design has been prepared by Professor P. C. Ricketts, Consulting Engineer, of Troy, N. Y., the Bridge Engineer of this road.

THE iron viaduct at Utica over the Delaware, Lackawanna & Western and the New York Central tracks, mentioned some time ago in the JOURNAL, is now about completed. A great deal of difficulty was experienced in getting a solid foundation, it having been found necessary to drive piles in some cases from 20 to 30 ft. During the excavation for the purpose of cutting off these piles at low water level in the Mohawk River an old trestle formerly in use by the Delaware, Lackawanna & Western was uncovered and the fact noted that for a distance of 6 ft. above high water the timbers were entirely sound, although at least 20 years old. This was probably due to the fact that, having been buried in the ground, they have been kept moist. This structure as a whole makes a marked feature on the line of the New York Central, adding one more to the many over and under crossings by which it is characterized.

THE Delaware & Hudson Canal Company has recently put into service an extensive coal terminal at Weehawken, N. J., consisting of 550 ft. of wrought-iron viaduct, comprising a single-track incline 300 ft. in length with a grade of 17 per cent., branching at its summit into a viaduct with four tracks above and one return track below. This viaduct extends 250 ft. to the dock line, and all five tracks are continued 1,300 ft. further into the stream upon a massive timber trestle, making a total length of about 1,850 ft., provided with chutes of the most improved pattern, with a variable mesh for use with different sizes of coal.

The cars are delivered by gravity from side tracks at the foot of the incline, and are drawn by endless rope and steam power to the summit of the latter, where they pass over the scales, which register their weight without arresting their motion. From the head of the incline to a point near the outer end of the timber trestle, about 900 ft., there is a descending grade of 1.4 per cent., and the impetus given by this grade is sufficient to carry the loaded cars around the 40° curves of all turnouts and cross-overs to the chutes, and to carry the light cars up a short incline at the outer end, where they retain sufficient impetus to start down the return track, which is located centrally between the others, with a grade of 3 per cent. This ends in a side track on the surface, connecting with the main tracks of the West Shore and the Erie railroads. Thus, by the use of grades only, no other power is needed from the time when the loaded cars pass the head of the incline until the light cars are in position to couple and pull out in a train for the mines. All switches work automatically, and that at the outer end, connecting the four east-bound tracks with the return track, designed by Mr. R. H. Brown, of the Delaware & Hudson Canal Company, serves its purpose particularly well in economizing room, which is of material value in a structure of this size.

On this trestle 8,000 tons of coal can be handled in a day, and it is considered an example of the best ideas yet evolved in this kind of structure.

The iron viaduct was built by the Rochester Bridge & Iron Works, and the general design prepared in accordance with the views of Mr. S. S. Smith, Superintendent.

The total cost of the work has been about $200,000.

## Marine Engineering.

THE John Roach Company at Chester, Pa., has recently laid the keel of a new steamship for the Ocean Steamship Company, of Savannah. The new vessel will be named the *City of Birmingham*, and will be 230 ft. long, 42½ ft. beam and 16½ ft. deep, with a carrying capacity of 2,300 tons.

THE Iowa Iron Company at Dubuque, Ia., is to build a steel steamboat for St. Louis parties; it will be the first steel boat on the Upper Mississippi. This boat will be 220 ft. long. 34 ft. beam and 5½ ft. hold. The engines will have two cylinders 17 in. diameter and 7-ft. stroke; the stern-wheel is to be 20 ft. diameter and 24 ft. bucket. There will be three boilers 40 in. diameter and 26 ft. long, with two 14-in. flues. The boat is intended to be faster than any boat now on the river.

THE Hoboken Land & Improvement Company has had plans prepared for a new steel boat for its ferry between Hoboken and New York. The boat will be 200 ft. long and 37 ft. beam, and will be driven by a propeller at each end. This will be entirely a new departure in Hudson River ferry-boats, as they are now, without exception, side-wheel boats. The new boat will be fitted up in the usual style and will cost over $100,000.

THE Globe Iron Works in Cleveland, O., launched on February 29 the steel steamer *E. P. Wilbur*, built for the Lehigh Valley Company's line between Buffalo and Chicago. The vessel is 290 ft. keel, 308 ft. long over all, 40 ft. beam and 25½ ft. deep; her carrying capacity is 2,650 tons. This is the largest vessel ever launched in Cleveland and will cost, complete, about $250,000. The engines are of the triple-expansion type, with cylinders 24 in., 38 in., and 61 in. diameter and 42-in. stroke, and will work up to 1,200 indicated H.P. Steam will be furnished by three boilers, each 11 ft. 10 in. diameter and 12 ft. long; the working pressure will be 160 lbs. The propeller wheel is 14 ft. diameter and 17 ft. pitch. The Globe Iron Works have three sets of stocks, and from one of these three vessels have been launched inside of 13 months.

## Car Heating.

THE Delaware & Hudson Canal Company has been recently using the Sewall system of steam heating on a train on its Pennsylvania Division, running between Carbondale and Wilkesbarre.

THE Erie Car Heating Company, which was recently organized at Erie, Pa., has its system of steam heating on trial on the West Shore, the New York, Chicago & St. Louis, the Lake Shore & Michigan Southern, and the Pittsburgh, Fort Wayne & Chicago roads. On the Fort Wayne road it has been in use on a local train running out of Pittsburgh for two years with much success.

WILLIAM BERRIGAN and Edwin K. Hanley, of Elmira, N. Y., have invented a system of heating trains by hot air. An air-pump on the locomotive forces air through a coil of pipes in the smoke-box, whence it passes through proper pipes and couplings to the cars. Each car is supplied with three hot-air reservoirs, placed under the floor, and communicating with the car through registers, by which the admission of heat to the car can be regulated. Safety-valves are attached to the reservoirs to prevent the pressure from becoming too great when the registers are closed. The inventors claim that the same system of pipes

and the air-pump can be used to supply a current of cool air in the summer. It is said that this system will be tried on a train on the New York, Lake Erie & Western Railroad.

### Manufacturing Notes.

RIEHLE BROTHERS, manufacturers of scales and testing machines, have removed their office and warerooms from No. 50 South Fourth Street to No. 413 Market Street, Philadelphia, Pa.

THE Railroad Commissioner of Michigan has given official notice that he has examined and approved the Janney and the Dowling freight-car couplers, and that the use of those couplers is now authorized on the railroads of the State, under the law.

THE Lansing Iron & Engine Works, in Lansing, Mich., have completed a new building, 258 by 45 ft., and three stories high. The works are doing a large business fitting out sawmills and supplying engine and mill machinery.

THE Industrial Works in Bay City, Mich., have recently shipped steam pile drivers to the Minnesota & Northwestern and to the Panama Railroad; steam shovels to the Michigan Central and a double 15-ton wrecking car to the Chicago, Rock Island & Pacific. They are also building four turn-tables for the last-named road.

THE Sheffield Velocipede Car Company at Three Rivers, Mich., notwithstanding a fire which destroyed several of its buildings, is actively at work. It is now erecting a roughing-out shop, 48 by 48 ft.; paint shop, 100 by 48 ft.; erecting shop, 108 by 60 ft., and an addition to the machine shop, 112 by 60 ft. These new buildings will make the shops larger than ever before.

A NEW company is to be organized for the manufacture of steel tires; the works will be at Grapeville, Pa., 27 miles east of Pittsburgh.

THE Britton Iron Works in Cleveland, O., which were partially destroyed by fire a short time ago, have been rebuilt, and are now running to their full capacity.

THE Cleveland Machine Company has removed its drop-forging business from Cleveland, O., to Chicago, and has transferred its other business to the Cleveland Machinery Company, its successor.

THE Volker & Felthousen Manufacturing Company in Buffalo, N. Y., has recently closed contracts for pumping machinery for water-works at Pine Bluff, Ark.; Jamestown, N. Y.; Owensboro, Ky.; David City and Stromsburg, Neb. The works are running overtime.

FRAZER & JONES, of the Syracuse Steel Foundry, have just put in operation their new works in Syracuse, N. Y., the capacity of which is about three tons per day of mild crucible steel castings. At these works last year over 500 locomotive cross-heads were made.

THE Phœnix Iron Works in Cleveland, O., are furnishing plant for the new pipe works of the Steel Company of Canada at Londonderry, N. S. This comprises one 10-ton steam-power crane and six hand-power cranes. The 10-ton crane is entirely of iron.

IN pursuance of the plan adopted some time ago, H. K. Porter & Company, in Pittsburgh, recently distributed among the employés of their works a share of the profits of the past year. The amount was about $15,000, and the individual shares varied from $2 to $300, according to rate of wages and length of service.

THE Wrought-Iron Bridge Company in Canton, O., is building a highway bridge over the Mississippi River between St. Paul and Minneapolis, Minn. There are two channel spans of 456 ft. each and several shorter spans, the entire length of the bridge being 1,273 ft. The contract price is $109,000, and it is to be finished by August next.

THE King Iron Bridge & Manufacturing Company in Cleveland, O., is building a new shop near the present one. It will be finished in June next and will be fitted up with the most approved machinery for iron and steel bridge and structural work. When this new shop is ready for use the company will be able to turn out 1,600 tons a month of finished work.

THE Home Electric Light Company in Oswego, N. Y., is introducing the Edison three-wire system of lighting into that city. The incandescent light plant will be run by a 90 H.P. Tonkin close-throttling engine, which, with the boilers, has been furnished by the T. Kingsford Foundry & Machine Works, of Oswego. A Tonkin high-speed, automatic cut-off engine of 300 H.P. will be used to run the street-lighting plant; for this the Remington dynamo and lamp will be used. Mr. F. J. Fisk has charge of the work.

THE Toledo Foundry & Machine Company in Toledo, O., recently closed a contract for a "Victor" railroad excavator for the Seattle, Lake Shore & Eastern Railroad Company in Washington Territory; also for another (the second furnished) for the Pennsylvania Railroad Company. One of this company's canal ditching machines was recently sent to the Kearney Canal & Water Supply Company in Nebraska.

IN the Lehigh Valley shops at Packerton, Pa., there was recently built a flat car of 120,000 lbs. capacity. This was made for the special purpose of carrying some heavy machinery from Perth Amboy to Bethlehem, Pa., for the Bethlehem Iron Company. The platform is 37 ft. long and 8 ft. wide. The car weighs 45,500 lbs., the trucks being 23,800 lbs. and the body 21,700 lbs. There are four intermediate sills 12 in. by 4½ in., and two side-sills of same dimensions, all of yellow pine and framed in channel beams. The body bolsters are made from channel beams and trussed by eight 1¼ in. rods and four 1¼ in. rods. The end-sills are of oak, 10×12 in., framed with wrought-iron plates, 8×¼ in., used as compression plates for truss rods. There are two trussed oak needle-beams in center. The car is carried on two six-wheel trucks, with 33-in. steel-tired wheels. The axles have journals 5 in. diameter and 9 in. long.

## Proceedings of Societies.

### National Electric Light Association.

THE seventh meeting of the National Electric Light Association was held at the Monongahela House in Pittsburgh. The first session began at noon on Tuesday, February 21, when the Convention was called to order by President J. Frank Morrison, who delivered a brief address on the Progress of Electric Lighting.

The Secretary then presented a number of communications and invitations, which were properly referred. The reports of the Secretary, the Treasurer, and the Executive Committee were presented and approved.

Professor F. Forbes, of London, England, was elected an honorary member.

The report of the Committee on the Insulation of Wires and Construction of Plant was read by the Secretary, and an elaborate paper on the same subject by Professor E. Thomson was also read; a brief discussion followed.

A paper by Dr. P. Lange, on the Protection of Watches against the Influence of Magnetism, was then read and discussed.

In the evening the members attended, by invitation, a meeting and reception of the Engineers' Society of Western Pennsylvania.

On the second day, February 22, at the morning session the report of the Legal Committee on the Importance of the Patent Laws was read and discussed; the committee was continued. Professor E. L. Nichols, of Cornell University, was elected an honorary member.

A paper on Leather Belting, giving an account of the recent improvements in its construction, was read by C. A. Schieren, of New York, and was briefly discussed.

At the afternoon session Dr. G. A. Liebig read an elaborate paper on Electric Motors, which called out an interesting discussion.

Mr. W. Lee Church then read a paper on Independent Engines for Incandescent Light Stations, in which he showed the necessity of making a careful choice of motive power for such stations, and enumerated the qualities which the engine for this purpose should possess.

Mr. Jarvis B. Edson then read a paper on the Economic Value of Steam Pressure Records, which was followed by a discussion.

Mr. S. E. Barden read a paper on the Relation of Electric Lighting to Fire Insurance, and G. W. Parker, of St. Louis, read one on the Qualities Constituting a Good Carbon Point.

On the third day some amendments to the Constitution were discussed and laid over until the next meeting.

The following papers were read: Distribution of Electricity by Alternate Currents, by T. C. Smith; the Energy of Alternating Currents, by O. B. Shallenberger; the Undergrounding of Electric Arc Light Wires, by W. W. Leggett; Underground Conductors for Electric Currents, by J. M. Smith. These papers were followed by a discussion on Underground Wires, which was not concluded until the afternoon session.

At the closing session a special committee was appointed on the Revision of the Constitution. It was decided to hold the next meeting in New York.

The usual resolutions, etc., were passed, and the following officers were elected for the ensuing year: President, S. A. Duncan, Pittsburgh; First Vice-President, E. R. Weeks, Kansas City; Second Vice-President, A. J. DeCamp, Philadelphia. Executive Committee, Dr. Otto A. Moses, Chairman; J. Frank Morrison, Baltimore; E. T. Lynch, Jr., New York; Frank Ridlon, Boston; T. C. Smith, Pittsburgh; E. F. Peck, Brooklyn.

## American Institute of Mining Engineers.

THE annual meeting began at the Hotel Brunswick, in Boston, February 21. General Francis A. Walker, President of the Massachusetts Institute of Technology, made an address of welcome, to which President Eggleston made an appropriate answer.

Papers were then read on Spirally Welded Tubing, by J. C. Bayles; New York Mining Law, by Professor R. W. Raymond; Recent Mining Accidents, by Charles A. Ashburner.

On the second day a long session was held for the reading of papers; those presented were as follows: The Topography and Geology of the Cerro di Pasco, Peru, by A. D. Hodges; the Formation of Fissure Veins, by S. F. Emmons; Recent Developments in the Open Hearth Process, by Alfred E. Hunt; Applications of Electricity to Mining, by G. W. Mansfield; the Bofors Steel Gun, by Captain O. E. Michaelis; the Husgafvel Improved High Bloomary for producing iron and steel direct from the ore, by F. L. Garrison.

The paper on Recent Mining Accidents was discussed by a number of members.

In the evening the annual dinner of the Institute was eaten, a large number of the members and guests being present.

February 23, the members of the Association went to Fitchburg, by special train, visiting the works of the Putnam Machine Company, the Fitchburg Steam-Engine Company, and the Simonds Rolling Mill Company; they also visited the works of the Waltham Watch Company, at Waltham.

In the evening a session was held at which papers were read on the Phosphates of the Ottawa Valley, by Robert Bell, and on the Plant of the Boston Heating Company, by A. V. Abbott; the last paper was discussed.

February 24, a greater part of the day was spent in visits to points of interest in Boston and vicinity. In the evening a business meeting was held, at which the reports of the Council and the officers of the Institute were presented and approved. The tellers announced the election, by letter-ballot, of the following officers for the ensuing year: President, Professor W. B. Potter, St. Louis; Vice-Presidents, J. C. Bayles, New York; Alfred E. Hunt, Pittsburgh, and T. Sterry Hunt, Montreal; Managers, Robert Forsyth, Chicago; Kenneth Robertson, Birmingham, Ala., and Charles M. Rolker, New York; Treasurer, Theodore D. Rand, Philadelphia; Secretary, R. W. Raymond, New York.

## Western Railway Club.

THE regular monthly meeting was held in Chicago, February 15. Mr. E. M. Herr read a paper on the effects of Magnetism on Watches; this was discussed by Messrs. Gibbs, Herr, Sinclair, and W. A. Smith.

The subject of Axles for 60,000-lbs. Cars was then taken up, and was discussed by Messrs. Hickey, Verbryck, Mackenzie, Nichols, and Forsyth; all of the speakers advocated heavy axles, but no decision was reached, and the subject was continued until the next meeting.

The third subject for the meeting was Six-Wheel Trucks Under Heavy Freight Cars, and this was also postponed until the next meeting.

## Southern Society of Civil Engineers.

THE thirteenth regular meeting was held recently at Jacksonville, Fla. Discussions on Drainage and Land Reclamation followed the regular order of business. The membership of the Society is rapidly increasing.

The following were elected officers for 1888: President, H. S. Duval, State Engineer of Florida; Vice-Presidents, Louis J. Barbot, J. E. Bozeman, M. L. Lynch, J. G. Mann, and T. R. Dunn; Treasurer, J. W. Bushnell; Secretary, T. S. Moorhead, Jacksonville, Fla.; Directors, R. N. Ellis, C. F. Smith, J. G. Gibbs, P. W. O. Koerner, and A. Bauer; Committee on National Public Works, Louis J. Barbot, N. E. Farrell, and T. S. Moorhead.

## New England Railroad Club.

THE annual meeting was held in Boston, March 14. The Secretary and Treasurer, Francis M. Curtis, read his annual report, showing the receipts of the year to have been $533, the expenditures $366, and balance on hand $167. There are 193 members, and the average attendance at the monthly meetings has been 64.

The Committee on Nominations reported the following list of officers for the ensuing year: President, James N. Lauder; Vice-President, George Richards; Secretary and Treasurer, F. M. Curtis; Executive Committee, J. N. Lauder, F. D. Adams, J. K. Taylor, J. W. Marden, Osgood Bradley, A. M. Waitt, Albert Griggs, J. T. Gordon, J. A. Coleman; Finance Committee, James Smith, Chairman, Isaac N. Keith, Robert Johnson, Charles Richardson, Joel Hill, A. G. Barber, David S. Page, George Draper. The report was accepted and adopted unanimously. President Lauder returned his thanks for his re-election, and stated that, his belief being that no man should hold office more than two years, he should not under any circumstances accept the office after this year.

The topic for discussion, continued from the previous meeting, Wheels and Axles, and their Relation to the Track, was taken up.

Professor C. F. Allen read a carefully prepared article, giving interesting statistics of the failures of wheels and axles on English railroads. The standard passenger wheel on English roads is a steel-tired one, but its excellence was claimed not to be due wholly to the fact that it is steel-tired, but to the general excellence of the wheel. Professor Allen expressed regret that the record of wheels in this country is not complete enough to base any conclusions upon.

Vice-President Richards stated that the wooden wheel referred to by Professor Allen is filled in from the tire to the hub with teak. Some of the wheels were tried some years ago on the Boston & Albany Railroad.

Mr. Adams said they were tried, but the climate was too much for them, the wood shrinking badly. Another experiment with the same wheel is being tried, and 16 of the wheels are now in service. Thus far they have done fairly well, but Mr. Adams is afraid the experiment will result about the same. The road is using steel-tired wheels, and during 17 years not a life has been lost by their breaking, though some have been discovered to be broken in season to take them out before any accident resulted. It has been several years since any wheels have broken until this winter, which has been unusually severe on wheels. It is very important to properly secure the tires on the wheels, though some persons might claim it would be better to have the entire wheel steel. The road has an almost absolutely correct manner of keeping a record of the mileage of all the wheels.

Mr. Coleman said, in considering the safety of wheels compared with those on English roads, the difference in climate and the superior excellence of the roads in that country should be considered.

Mr. Whitney coincided with the views of previous speakers regarding wooden wheels and the different conditions of climate and roadbed in this country compared with those in England. Notwithstanding those conditions, however, he thought if they would send good, honest wheels to this country, they would do as good service as on English roads.

Mr. Coleman contended that an iron wheel with a steel tire shrunk on it is bound to come to grief. He declared the same vicious system is in use in England in making cannon, and he believed that the entire armament of England will fail when brought to the actual test of war.

President Lauder said the breaking of tires on the driving-wheels of locomotives is very seldom seen.

Vice-President Richards described by means of a diagram on the blackboard the construction of wheels, and explained some of the causes of their failing.

Mr. Adams asserted that the most prolific cause of breaking of wheels is the splitting of steel tires occasioned by imperfections in the steel. He has known of very few instances where wheels have broken longitudinally. He knew of one case where the tire split entirely around.

Mr. Ellis called attention to the fact that English wheels are

much larger than those in use in this country. He spoke of the wooden wheels now made in England as showing greatly improved construction over those formerly made, and claimed they have been used in Germany and other countries to advantage.

Professor Swain spoke of the comparative cost of different kinds of wheels. The true way of comparing the cost of wheels is to see how much capital it would take to purchase the wheel and to return it, and the amount that would be obtained for it when worn out. He presented various figures as examples of this method of comparison.

The discussion continued for some time longer, a number of gentlemen participating.

## American Society of Civil Engineers.

A REGULAR meeting was held at the Society's House in New York, March 7, Mr. Mendes Cohen in the chair. The Secretary read the decisions of the committees examining prize essays, who awarded the Norman Medal to the paper on Evaporation, presented by Desmond Fitz Gerald, and the Roland Prize to the paper on Steel, some of its Properties, its Use in Structures and in Heavy Guns, by William Metcalf.

The Secretary then read a paper by John W. Hill, on Tests of an Edison Incandescent Electric Lighting Plant. The paper was a very full description, report, and tabulation of an elaborate eight days' working test of the cost, efficiency, and relative value, compared with gas, of the Edison plant in the Union Central Depot at Cincinnati, O. Mr. Hill found that, considering the actual illuminations compared, that of the electric lamps cost 39 per cent. more than the gas-light. He considered that the results of the tests indicated so great a loss of power between the engines and dynamos, that electricians should be stimulated to remedy it. The paper was discussed by Messrs. Flagg and Howell.

The tellers announced the result of the votes on amendments to the Constitution as follows: The amendment establishing a new student grade was lost by 137 affirmative to 142 negative.

The amendment providing for election of members by committee was lost by 67 affirmative to 212 negative.

The other proposed amendments relative to admission of foreign applicants and reconsideration of ballots were carried by votes of 251 and 226 affirmative to 32 and 55 negative respectively.

Elections were announced by the tellers as follows:

*Members:* Frederick James Amweg, Philadelphia; Oberlin Matthies Carter, Savannah, Ga.; Charles Sewall Gowen, Sing Sing, N. Y.; Charles Davis Jameson, New York; Edward John Landor, Canton, O.; Hunter McDonald, New Market, Ala.; George Romaine Olney, Morris Dock, N. Y.; Francis Ensor Prendergast, Newton Highlands, Mass.; George Henry Robinson, Marysville, Mon.; Edward Wegmann, Jr., Englewood, N. J.; Arthur Owen Wilson, Birmingham, Ala; John Young, Geneseo, N. Y.

*Associate:* John Haines Warder, Wilmington, Del.

*Juniors:* David Sylvanus Carll, Kansas City, Mo.; Charles Alfred Hasbrouck, Detroit, Mich.

## Master Mechanics' Association.

THE following circular has been issued by Secretary Angus Sinclair from his office, No. 175 Dearborn Street, Chicago:

MAGNETIC INFLUENCE OF IRON AND STEEL IN LOCOMOTIVES ON THE WATCHES OF ENGINE RUNNERS.

1. Have you noticed any variation in the running of your watch on or off your engine?
2. Have you noticed any variation in the running of your watch when in your regular daily employment, and when off one or more days?
3. Have you noticed any difference in the rate of your watch between summer and winter months?
4. Does the main spring of your watch break frequently?
5. How many times have you had a new main spring in your watch?
6. At what season of the year does the main spring break most frequently?
7. Have you noticed any coincidence of storms and breaking of main springs?
8. Have you noticed that the main spring would be broken after a thunder storm, or an electric disturbance of the atmosphere?
9. Do you compare your watch with the standard time daily?
10. Do you note the variation of the watch with the standard time absolutely, down to a second?
11. Do you set your watch when it is a little "off" time, or do you carry the variation in your mind?
12. Have you ever noticed any difference between the average running of watches carried by engineers and conductors?

Answers should not be confined to the above questions, but should include any information or suggestions that would be valuable to the Committee.

JAMES MEEHAN,
HARVEY MIDDLETON,
T. W. GENTRY,
*Committee.*

Replies to be addressed to James Meehan, Cincinnati, New Orleans & Texas Pacific Railroad, Ludlow, Kentucky.

## Master Car-Builders' Association.

THE following Committee circular has been issued from the office of the Secretary, No. 45 Broadway, New York, under date of March 20:

JOURNAL LUBRICATION AND THE BEST PRACTICE FOR ECONOMIZING OIL.

The undersigned Committee, appointed to consider this question and report at the Convention to be held in June, 1888, desires information on the following questions:

1. What kind of oil or grease do you use for lubricating journals of passenger cars?
2. What kind for freight cars?
3. Have you made any tests to determine the relative cost of lubricating journals with pure petroleum and with mixtures of petroleum and animal oils? If so, please give conclusions.
4. Have you experimented with any form of dust guard other than the M. C. B. standard? If so, and you have secured satisfactory results, please send drawings of the dust-guard.
5. What are your views as to the best methods to be pursued for the purpose of economizing oil in lubrication of car journals?

Please address your replies to this circular to J. W. Cloud, Buffalo, N. Y.

J. W. CLOUD,
H. ROBERTS,
J. N. LAUDER,
} Committee.

## Boston Society of Civil Engineers.

A REGULAR meeting was held at the rooms in Boston, February 15, President Rice in the chair. Joseph Coulson, Jr., C. Atherton Hicks, and John H. Webster were elected members, and seven names proposed for membership.

A letter from Mr. E. L. Corthell, of Chicago, member of the Society, was read in relation to the work of the Council of Engineering Societies on National Public Works, and referred to the Committee on National Public Works.

Mr. Henry Manley was appointed a committee to arrange for the annual dinner, and the usual appropriation was made for the same.

A committee, consisting of Messrs. F. P. Stearns, F. L. Fuller, and Frederick Brooks, was appointed to nominate officers for the ensuing year.

Mr. Frederick Brooks read the paper of the evening, entitled Sewage Disposal at Medfield, Mass.

Mr. Wilbur F. Learned also read an account of experiments made by him in the chemical treatment of the sewage at Mystic Lake.

## Civil Engineers' Society of St. Paul.

AT the regular meeting, in St. Paul, Minn., February 13, a number of applications for membership were received. A committee upon rooms was appointed to make arrangements for the meetings of the ensuing year. It was resolved to have the duplicate volumes of the Journal of the Association on Engineering Societies, now in possession of the Society, bound and to present the same to the St. Paul Public Library.

Letters from Mr. J. A. L. Waddell were read relative to introducing his pamphlet on Standard Specifications for Iron Bridges; they were referred to a special committee to report at the next meeting.

The President of the Society read a paper which was a report to the Council of Engineering Societies upon the methods at

present employed in conducting public works in France and Germany.

## OBITUARY.

CHARLES THEODORE PIERSON, who died in New York February 24, was for many years prominent in the iron trade in that city. He was connected with the management of the Ramapo Car Works and other manufacturing concerns. He was Receiver of the Grant Locomotive Works in Paterson some years ago, and aided materially in settling the affairs of that company.

W. W. HANSCOM, who died in San Francisco January 16, aged 48 years, was a mechanical engineer well known on the Pacific coast. He was connected with the construction of the cable railroad system in San Francisco, and was a strong advocate of the cable plan for street railroad traction. He was also connected with some cable road work in England. Mr. Hanscom invented a system of train brakes, which was one of those tried at the Burlington brake tests last year.

STURGIS MEEK, who died at Dunstall, England, February 16, aged 71 years, was one of the last survivors of the older generation of English engineers. He was a pupil of George Stephenson, and began work under him in 1833 on the construction of the London & Birmingham line. Later he was employed as a division engineer on the Paris & Rouen Railroad in France, and on the Dutch-Rhenish line in Holland, and as Assistant Engineer to Mr. Locke on the Great Northern Railway in England. In 1846 he was employed on the construction of the Midland Railway, and in 1853 he was appointed Engineer of the Lancashire & Yorkshire. Some years later he became Engineer-in-Chief of that company, and retained that position until his death. Mr. Meek had a high reputation as a locating engineer, and was also an authority on almost all questions relating to maintenance of way.

ENSIGN BENNETT, who died in Buffalo, N. Y., February 21, was born in Chautauqua County, N. Y., in 1831, and at an early age became a civil engineer. He was employed as assistant engineer on the old Cleveland, Painesville & Ashtabula road and afterward in the office of the City Engineer of Buffalo, and as Resident Engineer on the Erie Canal. In 1861 he entered the Government service, and was employed in building fortifications at various points. In 1864 he went to Indiana, and was concerned in several extensive contracts for building railroads. He returned to New York in 1875 and settled in Rochester. He built the Genesee Valley road, in which he was largely interested. In 1882 he removed to Buffalo, and took the management of the Fairmount Coal Company and other large coal interests, which he retained until his death.

JEAN BAPTISTE ANDRE GODIN, who died at Guise, France, in February, was widely known from his efforts to build up the co-operative principle both in manufacturing and living. Born a poor man, he built up, mainly by his business tact and his inventive genius, a large foundry business, employing a great number of workmen. In 1859 he planned the "Familistiere" or "Social Palace," as a home or dwelling-place on the social co-operative plan for all his employés. The plans were carried out as he desired, although the great buildings, owing to constant additions and the continual growth of the plans, were not finally completed for over 20 years. One of M. Godin's most prominent ideas was the importance of education, and so highly did he esteem it, that in the arrangement of the co-operative plans the cost of the schools was made a first charge, before any distribution of profits could be made.

The "Familistiere" attracted wide attention not only in France but in other countries, and many descriptions of it were published. To defend his plans from criticisms which were made, and to extend his ideas, M. Godin became an author. In 1871 he published the important work called "Solutions Sociales," and later the following four treatises, called: "La Richesse au Service du Peuple," "Les Socialistes et les Droits du Travail," "La Politique du Travail, et la Politique des Privileges," "La Souverainte et les Droits du Peuple." In 1878 he began to issue, as a means of propaganda for the social and associated political reforms which he desired, the weekly organ *Le Devoir*, to which he contributed a large portion of the most important articles. In 1881 appeared an elaborate treatise on the true principles and form of government ("Le Gouvernement") which, with "Les Solutions Sociales," constitute his chief works.

While opinions may differ as to the practicability of all M. Godin's ideas, and the possibility of applying them in countries where the conditions of life are different from those in France, he deserves the credit of making the first intelligent and successful effort to introduce the co-operative principle on a large scale.

THOMAS J. POTTER, who died in Washington March 9, was one of the best known and most successful railroad managers in the Northwest. He had been suffering for some time from a complication of diseases, and had been taken to Washington from Omaha, in the hope that a change of climate might prove beneficial. He was born in Carroll County, O., in 1840, and after working at various occupations as a boy, went to Iowa in 1862, and had his first railroad experience as lineman in an engineer corps on the Burlington & Missouri River Railroad. He soon left to enter the army; after the war he was a storekeeper for a time, but in 1866 went back to the Burlington & Missouri River road as station agent at Albia, and two years later was made Fuel and Claim Agent for the road. When the road became part of the Chicago, Burlington & Quincy system he was appointed General Agent at Creston, then Assistant Superintendent, and in 1875 Superintendent of the Iowa Division.

Mr. Potter was now in a position where his ability as a manager could be recognized, and his promotion was rapid. In 1878 he was made General Superintendent, in 1879 Assistant General Manager, and in 1880 General Manager of the road. From 1884 until about a year ago he was Vice-President and General Manager of the company. In May, 1887, he was appointed First Vice-President of the Union Pacific Company, with charge of the operation of all that company's lines. The work required to reorganize the management of that complicated system and to put it upon a proper basis was too much for him, and his health broke down some months ago. He was a man of strong character and excellent judgment, and his services were highly appreciated, as shown by the positions to which he attained. One of his most prominent characteristics was his promptness in deciding the questions which came before him, for he was one of those men whose first judgment was the best, and who did not have to wait for the second thought. With no influence to help him, he rose from the ranks by the force of his own abilities, and he always retained a kindly feeling for his old comrades.

ANDREW J. STEVENS died in Sacramento, Cal., February 11, aged 54 years. He was born in Barnard, Vt., and learned the trade of a machinist in the shops of the Northern Railroad at Concord, N. H. After working on that road and on the Vermont Central for a few years he went West, and was for seven years on the Chicago, Burlington & Quincy, part of the time as Foreman in the repair shops at Aurora, Ill. In 1861 he went to California, and after short terms of service on the Market Street Railroad and at the Vulcan Iron Works in San Francisco, he became Superintendent and Master Mechanic on the old San Francisco, Oakland & Alameda Railroad. When that road was absorbed by the Central Pacific he was made Division Master Mechanic; in 1870 he was promoted to be General Master Mechanic of the Central Pacific, holding that position until the road was leased to the Southern Pacific Company, when he was made General Master Mechanic of all the lines operated by that company. Mr. Stevens was a man of very active mind, and was continually engaged in devising improvements in construction. Among his more prominent improvements in locomotives were the Stevens steam packing for pistons, a balanced valve, and the Stevens valve motion with independent cut-off.

The Central Pacific built many of its own locomotives in its shops at Sacramento, and all of these were designed by Mr. Stevens, who brought into use many new devices of his own and others. Some years ago he built at these shops *El Gobernador*, which was designed for special service over the heavy grades of the Tehachapi Pass on the Southern Pacific, and which was at that time the largest locomotive in the world; and it has, indeed, been only exceeded in size by two or three others since built.

The Central Pacific, besides its rolling stock on land, owns a large fleet of ferry-boats and river steamers, and the machinery of these vessels was also under Mr. Stevens's charge. He built the machinery of a number of boats, and, as in the locomotive department, he introduced many improvements; among these was a steam-steering apparatus, which is now widely used. He designed and built the machinery of the *Piedmont*, the *Modoc*, the *Apache*, and other large boats, and also the engines and boil-

ers for the *Solano*, the largest ferry-boat ever built; he also designed and built the machinery for operating the ferry slips and landing stages at Oakland and San Francisco. The extensive shops at Sacramento and their machinery were also largely of his designing.

Mr. Stevens was highly esteemed by his subordinate officers and the men under his charge; while a strict disciplinarian and careful manager, he took much interest in his men, and always encouraged those who were anxious to advance. He was also highly esteemed in the community where he resided as a useful and public-spirited citizen. He leaves a wife, daughter, and one son.

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WILLIAM KELLY, who died in Louisville, Ky., February 11, aged 76 years, had a fair claim to the original invention of the Bessemer process for making steel. He was born in Pittsburgh, and was for several years engaged in the transportation and steamboat business. In 1845 he removed to Kentucky, and engaged in the manufacture of iron at the Suwanee Furnace and Union Forge in Lynn County. Here he began to introduce improvements, and commenced a series of experiments in the direction of decarbonizing the iron by the introduction of a current of air into the melted metal from the furnace. These experiments he continued for several years, with varying success, not wishing to make his process public until he had perfected it.

The following statement of his later action is taken from the *Iron Age*: "As soon as Bessemer brought out his process in England Mr. Kelly at once applied for a patent, and placed the matter in the hands of a well-known patent firm, who, it is claimed, retained the papers long enough to inform Mr. Bessemer and allow him to get out his patent, after which they notified Mr. Kelly that they had been engaged by other parties to obtain a patent for the same invention. However, a caveat was granted by the Patent Office, and the claim of Mr. Kelly was duly heard by the Commissioner, who decided that Mr. Kelly was the first inventor, and entitled to a patent, which was accordingly issued. In May, 1863, E. B. Ward, of Detroit, Mich., Daniel J. Morrell, of Johnstown, Pa., William M. Lyon and James Park, Jr., of Pittsburgh, Pa., and Zoheth S. Durfee, of New Bedford, obtained control of the patent of Mr. Kelly, and organized the Kelly Process Company, under an agreement which gave the inventor and his representatives an interest, which has been valuable. Experimental works were established at Wyandotte, Mich., and Mr. Durfee was sent to England to procure an assignment of Robert F. Mushet's patents, which had been found essential to the success of the process. This purpose having been accomplished, Mr. Mushet, Thomas D. Clare, and John N. Brown, of England, were admitted to membership in the company.

"In the autumn of 1864 Mr. William F. Durfee succeeded in making, at his experimental works at Wyandotte, the first steel ingots ever made by the pneumatic process in the United States; and on May 25, 1865, the first steel rails ever made in the United States were rolled from steel ingots. Meanwhile Alexander L. Holley had, in the interest of John F. Winslow and John A. Griswold, of Troy, N. Y., secured the patents of Henry Bessemer for the United States, but without the use of Mushet's patents they could not successfully produce steel; and, on the other hand, the Bessemer machinery was essential to the Kelly process. Therefore, in 1866, the interests of the several patentees were consolidated under the title of the Pneumatic Steel Association.

"Application was made at the United States Patent Office, in 1871, for the renewal of the Bessemer, Mushet, and Kelly patents, and the claims of the two former were rejected, while a renewal of seven years was granted to Mr. Kelly, it having been shown that he had not been sufficiently remunerated, having only received about $30,000 for the use of his patent, against $25,000 expenditures."

## PERSONALS.

J. M. JOHNSON has been appointed Chief Engineer of the Louisville Bridge & Iron Company, succeeding Gilman Trafton, deceased.

R. MONTFORT, for some years past Resident Engineer of the Louisville & Nashville Railroad, has been appointed Chief Engineer. That office has been vacant for several years.

R. E. RICKER has been appointed Superintendent of the Iron Mountain, the Little Rock & Fort Smith, and the Texas lines of the Missouri Pacific Company. He was recently on the Denver & Rio Grande, and was for a number of years on the Central Railroad of New Jersey.

ONWARD BATES is now Engineer and Superintendent of Bridges and Buildings of the Chicago, Milwaukee & St. Paul road, with office in Milwaukee.

JOHN ORTTON has resigned his position as Master Mechanic of the Eastern Division of the New York Central & Hudson River Railroad, which he has held with much success for several years past. Mr. Ortton has had many years' experience in England, Canada and the United States, and is a master mechanic of high standing in his profession. He has not yet decided on his future location.

J. M. LOWRY, for some time past General Master Mechanic of the Chicago, Milwaukee & St. Paul road, has been retired from that position at his own request, but remains with the company as Consulting Engineer of the Machinery Department.

WILLIAM SMITH, Superintendent of Motive Power and Machinery of the Boston & Maine Railroad, has had his jurisdiction extended over all the lines operated by the company, including the Boston & Lowell system.

D. C. RICHARDSON is now Master Car-Builder of the Boston & Maine Railroad and all its leased and controlled lines, and has his office at Lawrence, Mass. Mr. A. M. WAITT is Assistant Master Car-Builder, with office at Salem, Mass.

J. C. MUNRO was, on February 1 last, appointed Superintendent of Motive Power and Machinery of the Mexican National Railroad, with office at Laredo, Tex. His authority extends over all the divisions of the road, and all division master mechanics report to him.

S. H. HARRINGTON, for several years in charge of the drawing-room of the Pittsburgh, Cincinnati & St. Louis shops at Columbus, O., has been placed in charge of the drafting department of the New York, Pennsylvania & Ohio Railroad. Mr. Harrington is an active man, who has devised and introduced many improvements in construction.

MAJOR WILLIAM LUDLOW, late Engineer Commissioner of the District of Columbia, is now Engineer of the Fourth Lighthouse District, with station in Philadelphia.

PROFESSOR THOMAS GRAY, of the University of Glasgow, Scotland, has been appointed to the chair of dynamic engineering in the Rose Polytechnic Institute, Terre Haute, Ind., and has signified his acceptance of the position.

WILLIAM A. BALDWIN has resigned his position as Manager of the Pennsylvania Company's lines. He has been connected with the company for a number of years in various positions. Mr. Baldwin has accepted the position of Vice-President and General Manager of the Buffalo, Rochester & Pittsburgh Railroad.

LEWIS KISTLER has been appointed Master Mechanic of the Syracuse, Binghamton & New York and the Oswego & Syracuse divisions of the Delaware, Lackawanna & Western road, succeeding Mr. James Buchanan. He has been Foreman for several years.

JAMES BUCHANAN has been appointed Assistant Superintendent of Motive Power of the New York Central & Hudson River Railroad—a new office. He will have charge of the shops at West Albany. Mr. Buchanan has been for 14 years past on the Delaware, Lackawanna & Western road.

J. N. BARR has been appointed Superintendent of Motive Power of the Chicago, Milwaukee & St. Paul Railroad; he will have charge of the motive power and of the Car Department also. Mr. Barr has been for some time past Superintendent of the Car Department.

J. K. TAYLOR, Superintendent of Motive Power of the Boston & Lowell Railroad, resigned his position on February 29, in consequence of the lease of the road to the Boston & Maine. Mr. Taylor is well known in his department. He was at one time with the Manchester Locomotive Works, and afterward went to the Lake Shore road as Master Mechanic. More recently he was for several years Master Mechanic of the Old Colony Railroad; from that road he went to the Boston & Lowell.

## NOTES AND NEWS.

**Liquid Fuel for Steel Works.**—The Union Steel Company, of Chicago, is putting into the steel works a liquid-fuel plant to use crude petroleum. Two 1,000-barrel tanks are being erected, into which the oil will be pumped from cars, and from which it will afterward be pumped as required into smaller tanks for use at the respective batteries of boilers. The officers of the Company hope to be able to use it not only under boilers, but to substitute it for gas in the soaking pits and reheating furnaces.

**New Method of Sinking Wells.**—The old method of sinking wells or shafts by a wooden crib surmounted by masonry walls is superseded of late in Belgium by the use of hollow cylindrical sections of cement tubing of the required diameter, smooth externally, with inside collars jointed with liquid cement. As the excavation proceeds sections of the tubing are added at the top until the required depth is obtained, when the opening is closed with a cement slab, having a man-hole in the center.—*La Semaine des Constructeurs.*

**Anthracite Coal in India.**—It is quite true that anthracite coal of most excellent quality has been discovered in the hills along the Pishin Valley route from Sibi to Quetta. There is one seam, about half a mile in length, appearing like a black line on the side of the hill close to the station of Nasik. Small quantities of the best quality of this coal can be purchased locally at Rs. 14 ($5) a ton.—*Indian Engineering.*

**Blast Furnaces of the United States.**—The *American Manufacturer* gives the condition of the blast furnaces on March 1 as follows:

| | In Blast. | | Out of Blast. | |
|---|---|---|---|---|
| Fuel. | No. | Weekly capacity. | No. | Weekly capacity. |
| Charcoal | 62 | 11,713 | 111 | 13,316 |
| Anthracite | 102 | 29,066 | 98 | 26,277 |
| Bituminous | 129 | 76,800 | 85 | 45,239 |
| Total | 293 | 117,579 | 294 | 84,832 |

"There is a total in blast of 20 less than on February 1. Of this reduction, 8 are charcoal, 1 anthracite, and 11 bituminous. The weekly capacity of those in blast is 9,547 tons less than on February 1. Of this reduced capacity, 2,029 tons are at charcoal furnaces, 593 at anthracite, and 6,925 at bituminous."

On March 1, 1887, there were 349 furnaces in blast with a weekly capacity of 135,173 tons. The reduction this year, as compared with last, is thus 56 in the number of furnaces and 17,594 tons in the weekly capacity.

**Electric Lighting in Forts.**—The German Staff has recently adopted a system of electric lighting for forts, the luminous power of which is so great that it is stated that objects can be distinguished at night at a distance of 7½ miles. The details of the plan have been kept strictly secret. All the forts on the frontier are now being supplied with the plant, which is manufactured by Schuckert & Company, of Nuremberg.

One essential novelty of this apparatus is the use of parabolic mirrors as reflectors. The use of these mirrors, it is said, has made it possible to throw the light further than ever before.

French officers are now at work on the same question, the use of the electric light, and a system will shortly be adopted.

**Accidents on Indian Railroads.**—The returns for the three months ending June 30, 1887, give the number of persons killed and injured on the railroads of India as follows:

| | Killed. | Injured. | Total. |
|---|---|---|---|
| Passengers | 9 | 44 | 53 |
| Employés | 49 | 135 | 184 |
| Others | 57 | 20 | 77 |
| Total | 115 | 199 | 314 |

Of the passengers 9 were injured in train accidents; 9 were killed and 35 injured by falling from trains or in similar ways.

Nine employés were killed and 19 hurt in train accidents; 11 were killed and 23 injured in coupling cars. The rest were run over, fell from trains, etc.

Of the other persons 7 were killed and 5 hurt at grade crossings; 1 killed and 14 hurt while trespassing on the line, while no less than 49 are put down as suicides.

**American Steel Production in 1887.**—The *Bulletin* of the American Iron & Steel Association gives the following statement of the production of steel in the United States, in net tons:

| | 1887. | 1886. |
|---|---|---|
| Bessemer | 3,219,678 | 2,495,122 |
| Clapp-Griffiths | 68,679 | 46,371 |
| Open-hearth | 360,717 | 245,250 |
| Crucible | 84,421 | 80,609 |
| Miscellaneous | 6,265 | 2,651 |
| Total | 3,739,760 | 2,870,003 |

The increase last year over 1886 was thus 869,757 tons, or 31¼ per cent.

There were in operation during the year 34 Bessemer plants with 72 converters; 14 Clapp-Griffiths plants with 14 converters; 39 open-hearth plants.

The production of steel by various miscellaneous processes not included under the head of any above mentioned was 6,265 net tons, against 2,651 net tons in 1886. Most of this steel was made in Philadelphia and vicinity and in Pittsburgh.

**The Beam Engine for Steamboats.**—All the steamboats running on the Hudson River previous to 1824 belonged to the North River Line or Fulton & Livingston's Line, holding the monopoly of the water of New York State, and had "Square" engines. After the U. S. Supreme Court removed all barriers to the free navigation of the water of the State, in 1824, there were many opposition lines started, but none of the steamboats had beam engines until Robert L. Stevens, of Hoboken, N. J., placed on the river, in 1827, the *Albany*, the *North America*, and the *New Philadelphia*, all of which had that type of engine. the *North America* having a pair with cylinders 44 in. diameter and 8 ft. stroke, while the other two had single engines. It is more than probable that the *Albany*, built in 1826, was the first to run to Albany from New York of the three.

A few years previous to this date there were two or three ferry-boats on the North River ferries having beam engines, one of which was the *Hoboken*, built in 1822, and it is believed the *Pioneer*, built in 1825, also.

We are informed Mr. J. H. Morrison, of New York City, has the only full and correct list of steam vessels built in the United States, with their dimensions of hull and engines, that there is at the present day.—*Marine Journal.*

**American Public Buildings.**—It is not only jobbery in municipal and State architecture which makes our public buildings inferior as a class to those built by private enterprise. It is not only because the architect of the United States Government is changed from time to time that the works for which that Government is responsible are so often discreditable. The whole system by means of which the Government manages such matters is a bad one—bad not merely in the sense that it is not always well administered, but in the sense that it cannot be so administered as to result in an average of works which would rightly represent the standing of American architecture to-day. Until the system is radically changed—until the architectural business of the United States Government is put upon such a basis that it will tempt the hands of our very best architects, and will permit that many of them shall join in devoting to it a portion of their time—until this good day comes, American *citizens* may feel sure of being as well served (if they wish) as any individuals in the world, but the American *people* must be content with a worse service than any other nation accepts. It must be satisfied to put itself on record as too blind or too indifferent to see and appreciate and secure a quality of work which year by year excites an ever-growing admiration among our foreign visitors. It must submit to perpetuate the sins of a past generation of architects when it might be giving immense assistance to the virtues of the generation which is now at work and of those others which are to follow in its steps, if we may trust our English critics, with still greater freedom of effort and power and skill.—*The Century for March.*

**How Not To Do It.**—The object of this note is to call attention to an example of faulty construction which will, I think, appeal to those interested in the erection of modern buildings where the use of elevators is so universally demanded.

In a recently completed building in this city can be seen a system of four hydraulic elevators of what is considered approved construction, running in the four corners of a hollow square; the head works being carried by heavy wrought-iron beams extending from one wall to the other.

The sheaves carrying the hoisting ropes of all four elevators are properly placed on top of the beams mentioned, but owing to the fact that the hoisting ropes are all carried through the west wall, it became necessary to place the sheaves carrying the counter balances of the two elevators nearest the west wall, so that they would not interfere with the ropes of the elevators next the east wall.

The method of doing this is the point which I desire to criticise. The shafts of these counter-balance sheaves, instead of being so placed as to be supported by the beams, are hung from the bottom by what are apparently cast-iron bearings, attached to the lower flange of beams by means of two ¾-in. stud bolts. Aside from the uncertainty of obtaining a good thread when it has to be made in place, as these have evidently been done, there is added the uncertainty of the condition of the same, as well as of the bolts, by reason of the combination of "the monkey-wrench and the intelligent workman" who may have made the final adjustment.

In such cases where so many safety appliances are attached to prevent accidents, the faulty construction noted would seem to call for prompt remedy, as the giving way of the suspension boxes or bolts by reason of a sudden jar could hardly fail to cause an alarming accident, if not resulting in loss of life. A little forethought on the part of the designer of the machinery, or of the architect, would have suggested in this case a ready means of overcoming the difficulty encountered.—*Henry G. Morris, before the Engineers' Club of Philadelphia.*